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AIR POLLUTION ASPECTS OF EMISSION SOURCES: PRIMARY COPPER PRODUCTION

A BIBLIOGRAPHY WITH ABSTRACTS

ENVIRONMENTAL PROTECTION AGENCY

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Air Pollution Technical Information Center

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
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Research Triangle Park, North Carolina

June 1973

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AIR POLLUTION ASPECTS OF EMISSION SOURCES: PRIMARY COPPER PRODUCTION— A BIBLIOGRAPHY WITH ABSTRACTS

INTRODUCTION

The Air Pollution Technical Information Center (APTIC) of the Office of Air Quality Planning and Standards prepared, selected, and compiled the abstracts in this bibliography. The abstracts are arranged within the categories listed in the Contents. The abstracted documents are thought to be representative of available literature, and no claim is made to all-inclusiveness.

The subject and author indexes refer to the abstracts by category letter and accession number. The author index lists all authors individually; primary authorship is indicated by an asterisk. Generally, higher accession numbers have been assigned to more recent documents.

Current information on this subject and many others related to air pollution may be found in APTIC's monthly abstract bulletin.*

All of the documents abstracted by APTIC are currently on file at the Air Pollution Technical Information Center, Office of Air Quality Planning and Standards, Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Readers outside of the U.S. Environmental Protection Agency may seek the documents directly from publishers, from authors, or from libraries.

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*Air Pollution Abstracts, Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Includes more than 6300 abstracts and subject and author indexes in each issue, and two separate cumulative indexes. Subscription price: $27.00 per year; $6.75 additional for foreign mailing.

A. EMISSION SOURCES

12074

Rohrman, F. A., and J. H. Ludwig

SULFUR OXIDES EMISSIONS BY SMELTERS. J. Metals, 20(12):46, Dec. 1968.

Sulfur dioxide and trioxide are emitted during the roasting and smelting of most copper, lead, and zinc concentrates. The 32 major smelters in the U. S. account for roughly 12.2% of the total emissions of SO2 in the country. This is a brief review of some of the statistics.

12751

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME II: APPENDICES A AND B. Contract PH 86-65-85, Rept. 993, 88p., June 1969. 72 refs. CFSTI: PB 184 885

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economi factors that bear on the problem of control of sulfur oxide emissions. Sulfur oxide emissions for various types of smelting operations are tabulated, including gas flows and compositions and an analysis of sulfur oxides generation and recovery. Smelter flow diagrams are presented for the control methods of contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Sulfur oxide recovery processes that were investigated and rejected as not being suitable for economic analysis are listed. Cost estimates for various control processes are given.

12823

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOL I. Contract PH 86-65-85, Rept. 993, 188p., June 1969. CFSTI: PB 184 884

A systems study of the primary copper, zinc, and lead smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. The nature of smelting practice is described, and potential air pollution problems in smelter areas are revealed. Five processes for the control of sulfur oxides are presented, including contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Current sulfur oxide emissions from U. S. smelters are given, and forseeabl emission trends are discussed. Markets for sulfur byproducts are mentioned, the costs of control by available methods are tabulated, and control method evaluation with plant models is considered. A research and development program for control methods and smelting process technology is recommended.

13294

McKerrow, G. C.

A 14 X 32 FT. CONVERTER AT THE NORANDA SMELTER. In: Pyrometallurgical Processes in Nonferrous Metallurgy, J. N. Anderson and P. E. Queneau (eds.), Metallurgical Society Conferences vol. 39, Am. Inst. Mining, Metallurgical, and Petroleum Engrs., 1967, p. 247-258. (Symposium sponsored by the Extractive Metallurgy Div. of the Am. Inst. Mining, Metallurgical, and Petroleum Engrs., Pittsburgh, Pa., Nov. 29- Dec. 1, 1965).

Construction of a new 14 ft converter at Noranda Mines Ltd. to increase copper production was started after reviewing the possibilities of the use of O2-enriched air, adding a sixth converter, and replacing the 12 X 30 ft converter with a larger one. The new converter is equipped with a water-cooled hood and breeching to avoid fusing the flue dust. Water circulates in a closed circuit between the water jackets and a heat exchanger which maintains the water temperature between 90 and 120 F. The area of the water jackets is 550 sq ft and an average of 120,000 Btu/min are removed from the gases while the converter is blowing. Better fitting of the hood and breeching have reduced the volume of converter gas going to the cottrells below the level from the 12 ft converter. Flux is fed through the hood, since the normally-employed Garr guns could not feed flux fast enough. Fifty automatic punchers, in two banks of 25 each, are sequentially fired, with a 20 to 30 sec interval between banks. The tuyeres are reamed manually at least once every 24 hrs. Air volume to the converter was initially 32,000 scfm with 8 psig at the blast valve. This dropped below 25,000 scfm at 15 psig after several days. Increasing the diam of the punch bars and reaming rods by 0.125 in. increased the volume to 28,000 to 30,000 cfm. The converter is initially charged with six 200 cu ft ladles of matte, 2 ladle skulls and 50 tons of flux. Four or five ladles of slag are skimmed and four more ladles of matte are charged after 75 min, with subsequent 2 ladle additions made. About three hours are required to finish a 140 ton charge of copper from white metal, giving a net production of 110 to 115 tons.

17471

Knop, Wilhelm

INDUSTIRAL DUSTS AND WASTE GASES. (Industriestauebe und-abgase). Text in German. Wasser Luft Betrieb, 14(2):63-66, Feb. 1970. 22 refs.

The most dangerous and annoying pollutants emitted by various industries are enumerated. Steel mills emit primarily iron oxides and fluorine compounds. Half of the original fluorine input is emitted; the other half goes into the slag. The iron oxide emissions, primarily the small particles below 5 micron, form the brown smoke. The non-ferrous metal fabricating and finishing plants emit metal oxides (cadmium oxide). When inhaled, the latter may be extremely harmful. The TLV (threshold limit value) is 0.1 mg/cu m air. In aluminum production, dust-laden waste gases develop, despite the wet process. The aluminum oxide dust content in the rotary furnace is 300-400 g/standard cu m. In electrolytic reduction of aluminum ox-

ide, cryolite also dissociates. As a consequence, hydrogen fluoride and dusts of fluorine compounds are found in the waste gas. The TLV for fluorides is 2.5 mg/cu m; for hydrogen fluoride, 2 mg/cu m. In lead plants 3 to 3.5 cu m waste gases per kg sinter develop in the sintering and roasting station. They contain 1.5 to 5% by volume SO2 and up to 15 g/cu m dust. The dust contains lead, zinc, sulfur, and small amounts of other elements. Considerable amounts of metal vapors develop. In the fly dust of the shaft furnaces, cadmium oxide or sulfate, arsenic, zinc, and thallium compounds may be found. In copper smelting plants, the waste gases contain fly dust and SO2. In zinc refining, fly dust (0.1 g/standard cu m) and SO2 are emitted to the waste gas. In ferro-alloy production, dusts of various kinds are carried along in the waste gases. The waste gas quantity of a 10 MW furnace amounts to 70,000-250,000 cu m/h; the dust content, to 0.25-2.5 g/cu m.

18184

Leroy, J., and P. J. Lenoir

HOBOKEN TYPE OF COPPER CONVERTER AND ITS OPERATION. Preprint, Institution of Mining and Metallurgy, London, 11p., 1967. (Presented at the Advances in Extractive Metallurgy Symposium, London, April 17-20, 1967. Paper 15.)

Copper converting gives off large quantities of sulfur gases. With standard converters blowing in a hood, serious dilution of gases is unavoidable, and the sulfur is only partially recovered. The siphon converter was developed to eliminate dilution of gases by maintaining a constant zero draught at the converter mouth by means of a variable-speed fan and adequate dampers. The dampers are electrically interconnected, as are the fans and the dampers. This insures that gases containing SO2 cannot be released directly into the stacks. Disadvantages of the siphon converter are a greater initial capital outlay, the greater amount of ground space required, and a fairly heavy counterweight that is used to compensate for the weight of the siphon. Mathematical comparisons are made between a conventional converter and a siphon converter.

18306

Pings, W. B., and Earl L. Rau

RECENT TRENDS IN COPPER METALLURGY. Mineral Industries, 2(4): 18p., July 1968. 86 refs.

Two major sources of copper are sulfide ores and oxide ores. The predominant CuS minerals are chalcopyrite, chalcocite, bornite, enargite, and covellite. The chief oxidized minerals are chrysocolla, malachite, and azurite. Sulfide ores are treated by concentrating, smelting, and refining. Oxidized ores are treated by leaching followed by precipitation or electrowinning. Recent trends in leaching have been aimed at higher Cu recovery from given ores, or the production of Cu from ores that could not be processed economically in the past. Bacterial, pressure, and cyanide leaching are covered. Cone type and V-trough precipitators use iron to precipitate Cu from CuSO4 solutions. Sponge iron is being incorporated in these processes to give faster precipitation. Precipitation from aqueous solutions by reduction with H,S and SO2, and HCN and SO2 are discussed. Advances in solvent extraction have increased Cu recovery to better than 98%. Estimated installed plant cost for a liquid ion exchange solvent extraction plant is between $500 and $600/gal/min. A new electrolytic cell (CCS process) is more efficient than standard cells, produces smooth cathode deposition, and operates at lower costs. In situ leaching following nuclear blasting shows promise as a new mining technology. The WORCRA and Normanda processes are relatively new pyrometallurgical techniques which increase smelting efficiency. Continuous converting and smelting in converters with oxygen have reduced the number of steps in copper production with attending decreases in capital and operating costs. Scrap metal can now be successfully stripped of copper by dipping in molten barium chloride at 1250 C. Iron and steel are not affected by the bath, and the usual trapped puddle problem is eliminated.

21617

Fachvereinigung Metallhuetten und Umschmelzwerke E. V., Emissionsausschuss and Gesellschaft Deutscher Metallhuetten - und Bergleute E. V., Hue Hendusschuss fuer Kupfer und Alknliche Metalle

RESTRICTION OF EMISSION COPPER-ORE MILLS. (Auswurfbegrenzung Kupfererzhuetten). VDI (Ver. Deut. Ingr.) Richtlinien, no. 2101, Sept. 1966. 14 refs. Translated from German by D. Ben Yaakov, Israel Program for Scientific Translations, Jerusalem, 13p. CFSTI: TT 68-50469/7

The technology of copper mills is reviewed with respect to dust separation methods and factors affecting dust content for the various operations in the production cycle: roasting furnace, sintering grate, shaft furnace, reverberatory furnace, copper-matte converter, copper refining (anode) furnace, copper electrolysis, and wirebar furnace. Engineering means of reducing emissions from each of these processes, except electrolysis which does not produce any dust-bearing gases, are described: cyclones, electrostatic precipitators, dust chambers, multicyclones, and fabric filters. Factors affecting the efficiency of various dust collectors are outlined. For newly constructed copper mills and new units, an emissions limit of 0.3 g/cu m STP is established for the various processes. In addition, new roasting furnaces, sintering machines, and converters must be designed to ensure that all SO2-bearing flue gases from these units are used in sulfuric-acid manufacture, and stack-height regulations must be followed. It is noted that dust control is of economic as well as environmental interest, since the dust emitted from a copper mill constitutes a loss of valuable metals such as zinc, tin, lead, and copper.

23036

Haywood, J. K.

INJURY TO VEGETATION BY SMELTER FUMES. U. S. Dept. Agr. Bur. Chem., Bull. 89, 23p. 1905. 4 refs.

Investigations were conducted to determine whether fumes from a copper smelter were injurious to vegetation and, if so, how large an area was affected. About 60 samples of trees, water, soil, and ore were taken from distances one to three miles from the smelter and subjected to chemical analysis, from which very definite results were obtained. Of 26 groups of trees examined, the percentage of sulfur trioxide in leaves was higher in injured trees than in uninjured. In most cases, the increased sulfur trioxide concentrations were attributable to sulfur dioxide fumes. The sulfur trioxide concentrations varied with distance from the smelter, and high concentrations were correlated with prevailing wind direction. The sulfur content of the ore in the area was found to average 41.48%. It is assumed that 90% of the sulfur is liberated by the extraction of copper and that the plant gives off 748 tons of sulfur dioxide a day. Water in a creek running by the smelter was not only very acid but contained traces of arsenic and dissolved copper. Injury to vegetation in the area is expected to continue unless the smelter fumes are condensed.

23287

Haywood, J. K.

INJURY TO VEGETATION AND AMIMAL LIFE BY SMELTER WASTES. Dept. of Agriculture, Washington, D. C., Bureau of Chemistry, Bull. 113 (Rev.), 63p., July 7, 1910. 22 refs.

The injurious effects which wastes from sulfur-bearing copper ore smelting operations have on animal and plant life are considered. Sulfur contained in the ore is given off as sulfur dioxide and sulfur trioxide. Arsenic, which is often present in the ore, is given off in fumes which settle out and deposit on the crops surrounding the smelter. Waste water containing copper can percolate through the ground and reach streams. Particulates discharged through the stack settle out, causing injury to plant life. Mechanisms of damage to plants are discussed, and thresholds for SO2 are given. Results of field investigations to determine the extent of damage to plants are reported. Trees, corn, wheat, and other plants are injured to varying degrees. Studies of the arsenic content of crops and soils prove that cattle deaths are attributable to arsenic poisoning. Methods of analysis used on plants, soils, water, and ores are described.

24285

Swain, Robert E.

SMOKE AND FUME INVESTIGATIONS. A HISTORICAL REVIEW. Ind. Eng. Chem., 41(11):2384-2388, Nov. 1949. 18 refs.

Several outstanding cases of injury to animal and plant life by emanations from industrial plants at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah, and Trail, B. C. are cited in a historical survey of atmospheric pollution and the steps that have been taken to prevent and combat it. Sulfur dioxide from two copper smelters was the offender in Ducktown, reaching for 30 miles across the broad-leafed forests of northern Georgia. A crisis came when Georgia brought suit against Tennessee to compel it to cancel the franchise of the smelting companies, but out of this came the design, erection, and successful operation of an adaptation of the lead chamber process to convert SO2 from copper smelting operations to sulfuric acid. With the installation at the Anaconda smelter in 1910 of an enormous Cottrell system for electrical precipitation of solids, one of the most remarkable cases of injury to livestock by smelter smoke ever recorded passed into history. The emissions from the low stacks of an old plant operated at a neighboring location had killed all vegetation, and losses of livestock by arsenical poisoning had been heavy over the near-lying area. A new smelter was erected with stacks over 300 feet tall, but there were still emitted daily 2300 tons of SO2, 200 tons of sulfur trioxide, 30 tons of arsenic trioxide, 3 tons of zinc, and over 2 tons each of copper, lead, and antimony trioxide. Lead and SO3 fumes were soon put under complete control in Utah by liming and bag filtration, and by electrical precipitation. About $13,000,000 was invested at Trail in recovering airborne wastes and converting them to marketable by-products. These were tied together into a smoothly operating system and soon phosphate fertilizers of several types, ammonium sulfate, and sulfur were being produced on a large scale. Contributions of research and diurnal fumigation are also discussed.

26441

Oglesby, Sabert, Jr. and Grady B. Nichols

A MANUAL OF ELECTROSTATIC PRECIPITATOR TECHNOLOGY. PART II -- APPLICATION AREAS. Southern Research Inst., Birmingham, Ala., NAPCA Contract CPA 22-69-73, 875p., Aug. 25, 1970. 118 refs. NTIS: PB 196381

The application of electrostatic precipitators is reviewed for the electric utility industry, the pulp and paper industry, the iron and steel industry, the rock products industry, the chemical industry, in cleaning municipal incinerator dusts, for the petroleum industry, and in the nonferrous metals industry. Particular emphasis is placed on the dust and gaseous emissions of the processes discussed. This is followed by a tabulation of input and design parameters for precipitators operating on various types of dust control problems and an analysis of critical design parameters and test results. Cost data are also presented. The electrolytic reduction of aluminum, the production of copper, primary lead, and zinc reduction are discussed in the area of the nonferrous metals industry. In the petroleum industry, catalytic cracking and dearring are indicated as application areas. Refuse properties are discussed, as well as types of incinerators. Sulfuric acid production, the production of elemental phosphorus, phosphoric acid, and carbon black, warrant the use of precipitators in the chemical industry. In the rock products industry, the manufacture of Portland cement and the gypsum industry present problems. Coke ovens, sinter plants, blast furnaces, open hearth furnaces, basic oxygen converters, electric arc furnaces, scarfing machines, and iron cupolas are areas of application in the iron and steel industry. In the pulp and paper industry, precipitators are indicated for the recovery of boiler particulate emissions and sulfate process flue gases. Fly ash precipitators are needed in the electric utility industry.

30447

Nelson, Kenneth W.

NONFERROUS METALLURGICAL OPERATIONS. In: Air Pollution. Arthur C. Stern (ed.), Vol. 3, 2nd ed., New York, Academic Press, 1968, Chapt. 37, p. 171-190. 16 refs.

While sulfur dioxide from the smelting of copper, lead, and zinc has been the principal pollutant of interest in nonferrous metallurgy, gaseous and particulate fluorides from aluminum smelting are also of concern. Fluoride problems first came to attention because of adverse effects on grazing animals rather than effects on vegetation, as with SO2. The mining, milling, and concentrating of copper, lead, and zinc are discussed, as well as their refining and smelting, emissions, and controls. The mining and ore treatment of aluminum is considered, its electrolysis, and emissions and controls. Copper, lead, zinc, and aluminum produced from scrap are also discussed. The production of nonferrous alloys is noted.

34916

Bureau of Census, Washington, D. C.

PRODUCT CLASSES - VALUE SHIPPED BY ALL MANUFACTURING ESTABLISHMENTS: 1947, 1954, 1958, 1963 TO 1967. In: Smelting and Refining of Nonferrous Metals and Alloys. p. 33C-29, 1970.

Quantities shipped by all manufacturing establishments of copper, lead, zinc, aluminum, primary nonferrous metals, and secondary nonferrous metals are tabulated for 1947, 1954, 1958, and 1963 to 1967. Both smelter and refined materials are included.

35224

Halley, James H. and Bruce E. McNay

CURRENT SMELTING SYSTEMS AND THEIR RELATION TO AIR POLLUTION. Preprint, American Inst. of Chemical Engineers New York and Inst. Mexicano de Ingenieros Quimicos, 20p., 1970. 5 refs. (Presented at the American Institute of Chemical Engineers and Institute Mexicano de Ingenieros Quimicos, Joint Meeting, 3rd, Denver, Colo., Aug. 30-Sept. 2, 1970.)

The non-ferrous smelting operations, using metallic sulfides as feed material, are briefly described. These include copper, lead, and zinc smelting. Conditions and the nature of waste gas streams are discussed in relation to extraction and recovery of sulfur. Major problems of high temperatures, unclean gases, and low sulfur oxide concentration are noted. Possible changes in equipment and processes are discussed, as well as the manufacture of sulfuric acid from relatively strong sulfur dioxide waste gas. (Author abstract modified)

39462

Midwest Research Inst., Kansas City, Mo.

PARTICULATE POLLUTANT SYSTEM STUDY. VOLUME III - HANDBOOK OF EMISSION PROPERTIES. Air Pollution Control Office Contract CPA 22-69-104, MRI Proj. 3326-C, 626p., May 1, 1971. 302 refs.

Details of the methodology employed to obtain data concerning the kind and number of stationary particulate sources, the chemical and physical characteristics of both the particulates and carrier gas emitted by specific sources, and the status of current control practices, are presented. Emission factors and rates, chemical and physical properties of effluents, and control practices and equipment are given for stationary combustion processes (power generation and furnaces); mineral processing; agricultural operations (field burning, grain elevators, cotton gins); iron and steel manufacturing; cement manufacturing; forest products industry (sawmills, pulp industry); primary nonferrous metallurgy (copper, lead, zinc, and aluminum smelting and refining); clay products; fertilizer manufacturing; asphalt; ferroalloy manufacturing; iron foundries; secondary nonferrous metals industry; coal preparation; carbon black manufacturing; petroleum refining; acid manufacture (sulfuric acid and phosphoric acid); and incineration. The control equipment includes cyclones, wet scrubbers, electrostatic precipitators, fabric filters, mist eliminators, and afterburners. Effluents include dusts, particulates, fly ash, sulfur oxides, hydrocarbons, and other noxious gases. Costs for control equipment purchase and operation are given. This handbook constitutes a reference source for available information on the distinguishing features of the various particulate pollution sources and should be of value to air pollution regulatory agencies, control equipment manufacturers, and industrial concerns.

40085

Grey, Donald C., Mead LeRoy Jensen, and Henry L. Dequasie

ATMOSPHERIC FLUIDS PROVENANCE USING STABLE ISOTOPES. Utah Univ., Salt Lake City, Lab. of Isotope Geology, Public Health Service Grant 1 RO1 AP00627, Trans. 01051441, Rept. 5242, 51p., Sept. 1971. 23 refs.

The technique of isotopic fingerprinting has proven useful in the Salt Lake Valley for determining the source of sulfur pollution. The several sources of atmospheric sulfur compounds in the area are isotopically characteristic, and their effluents can generally be distinguished, and their relative contributions to the general levels in the atmosphere determined. In the Salt Lake Valley, the major source of atmospheric sulfur compounds is a large copper smelting operation. Bacteriogenic hydrogen sulfide appears to be the second largest source. Petroleum refineries and a coking operation were minor contributors. Increasing levels of carbon dioxide were fossil fuel consumption by metal smelters in the Salt Lake City area and were often seven or eight times the mean level for the free atmosphere. Metal smelters produce larger quantities of CO2 than sulfur dioxide. Routing and rapid sampling for isotopic analysis is now possible using a particle filter, followed by a 3 angstrom sieve dehydrator, followed in turn by a smaller volume 4 angstrom sieve on which the sample was collected. A 70 cfm blower drawing air at about 12 cfm powered the unit. The motors used were high speed units designed for 110 vac and were run on inverters for field use. (Author abstract modified)

40284

Morita, Clyde B.

PHOENIX-TUCSON METROPOLITAN AREA AIR POLLUTANT EMISSION INVENTORY. National Air Pollution Control Administration, Durham N. C., Air Quality and Emission Data Div., Office of Air Programs Pub-APTD-0827, 51p., Oct. 1969. 13 refs.

Estimates are provided of total emissions of oxides of sulfur, oxides of nitrogen, hydrocarbons, carbon monoxide, and particulate matter. The emissions of these pollutants are delineated with respect to source type, season of the year, and geographical distribution. Source categories considered were transportation, stationary fuel combustion, solid waste disposal, industrial process losses, organic solvent evaporation, and agricultural operations. Facilities that emitted large quantities of pollutants were considered individually. The predominant source (99.7%) of the more than 2 million tons of sulfur oxides emitted in 1967 was the copper smelting industry. Various source types, including transportation, industrial process, and agricultural operations contributed to the 34,300 tons of particulate matter. Motor vehicles accounted for 94% of 535,000 tons of carbon monoxide. The two largest sources, contributing 57% and 28% respectively, of the 125,000 tons of hydrocarbons were motor vehicles and organic solvent evaporation. Motor vehicles also contributed more than 55% of the 62,400 tons of nitrogen oxides.

41681

Foard, James E. and Russell R. Beck

COPPER SMELTING. CURRENT PRACTICES AND FUTURE DEVELOPMENTS. Preprint, American Inst. of Mining, Metallurgical and Petroleum Engineers, (AIME), New York, N. Y., 51p., 1971. 42 refs. (Presented at the American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting, New York, Feb.-March 1971.)

The current structure of the copper smelting industry is reported in terms of the number, distribution, type, and value of smelters in the United States and abroad. The balance between U. S. smelting capacity and domestic concentrate production is examined. The cost of smelting and the pollution abatement factors which affect it are analyzed. Currently practiced smelting methods include reverberatroy furnace, flash furnace, electric furnace, blast furnace, and shaft furnace smelting, converting operations, gaseous deoxidation of molten copper, and slag flotation. Areas of process and equipment development in which there has been much activity but which have not yet reached the state of complete commercial feasibility include: continuous smelting, oxygen top blowing, cyclone smelting, separate melting of precipitates, charge preparation, and recovery of metal values from slag. A copper smelter designed to meet the future requirements of effective pollution abatement, continuous smelting, conservation of fuel and power, simplification, improved working conditions, and economic feasibility is described. 0

42676

Ministerium fuer Arbeits, Gesundheit und Soziales des Landes Nordrheim-Westfalen, Duesseldorf (West Germany)

NONFERROUS METALLURGY. (NE-Metallerzeugung). Text in German. In: Reine Luft fuer morgen. Utopie oder Wirklichkeit. Moehnesee- Wamel, West Germany, K. ron Saint George, 1972, p. 60-65.

The present situation and future trends in the output and emissions in the nonferrous metallurgy of North Rhine-Westphalia are described. The aluminum industriy, which accounts for more than 50% of the total output of West Germany, will experience rapid growth. The basic pollutants are gaseous fluorine compounds (0.8-1.5 kg/t), aluminum- and fluorine-bearing dust (9-20 kg/t), sulfur dioxide (3-15 kg/t), and carbon monoxide. Aluminum remelting is expected to increase 100% by 1980. Chloride aerosols, metal oxides, and gaseous fluorine compounds are the chief pollutants. Dust separation at a rate of 15% was applied to rotary furnaces in 1970. Dust emissions will decrease from 1320 tons in 1970 to 680 tons in 1980 by lowering the dust concentration to 150 mg/N cu m and 100 mg/N cu m for rotary furnaces and thermal chips treatment facilities, respectively. Gaseous fluorine emissions, 90 tons in 1970, will be reduced to 50 tons in 1980 by applying wet-type gas cleaning. Sulfur dioxide emissions from lead manufacturing will be reduced 90% due to waste-gas desulfurization. The efficiency of SO2 separation at sulfuric acid production facilities is 98%. Lead and zinc emissions, amounting to 350 and 180 tons in 1970, will decrease to 50 tons each in 1975. Sulfur dioxide emissions from copper manufacturing, for which a 2% yearly rate of growth is predicted, will rise from 900 tons in 1970 to 1100 tons in 1980, the waste-gas SO2 concentration being 0.2 g/N cu m. Hydrochloric acid emissions, now 500 tons, will decrease by 50%. While total dust emission will be reduced from 600 to 300 tons, no further reduction in lead, zinc, and copper emissions is possible. The dust emissions from copper alloy manufacturing will be 10% of the 1970 level by 1980, as an upper limit of 50 mg/N cu m will be set in 1973. Sulfur dioxide emissions from zinc manufacturing, for which electrolytic processes are increasingly used, will decrease from 1800 tons in 1970 to about 1500 tons in 1980. The imposition of a maximum allowable dust emission of 50 mg/N cu m in 1973 will result in zinc and lead emissions, now 160 and 40 tons, decreasing to 80 and 20 tons, respectively, despite a growth rate of 40%.

43271

Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs

METALLURGICAL INDUSTRY. In: Compilation of Air Pollutant Emission Factors. OAP Pub-AP-42, p. 7-1 to 7-22, Feb. 1972. 61 refs. NTIS: PB 209559

Primary and secondary metal industries are discussed. The primary industries, producing metals from ore, reviewed are: non-ferrous operations of aluminum ore reduction, copper smelters, lead smelters, zinc smelters, iron and steel mills, ferroalloy production, and metallurgical coke manufacture. Large quantities of sulfur oxides and particulates are emitted by these industries. The secondary metallurgical industries, which recover metal from scrap and salvage and produce alloys from ingot, include aluminum operations, brass and bronze ingots, gray iron foundries, lead smelting, magnesium smelting, steel foundries, and zinc processing. The major air contaminants from these operations are particulates in the forms of metallic fumes, smoke, and dust. Control methods used are: cyclones, electrostatic precipitators, filters, and baghouses.

45387

Lavrov, N. V. and S. F. Evlanov

PREPARATION OF REDUCING GAS WITH HIGH HYDROGEN CONTENT BY THE PYROLYSIS OF NATURAL METHANE IN MELTS. (Polucheniye nosstanovitel nogo gaza s nysokim soderzhaniyem nodoroda pirolizom prirodnogo metana v rasplavakh). Text in Russian. Tsvetn. Metal., 45(3):12-14, 1972. 6 refs.

Natural gas was bubbled through liquid copper, iron, and tin at 1200-1500 C to decompose the hydrocarbons. The hydrogen concentration of the pyrolyzed gas increased with temperature to greater than 90% volume at greater than 1400 C. The pyrolysis degree increased more than the temperature rise than with the decreasing gas flow rate. Addition of an equal volume of steam to natural gas decreased the carbon black formation, but formed approximately 15% carbon monoxide by volume. The results are useful for copper refining with natural gas.

48296

Grey, D. C. and M. L. Jensen

BACTERIOGENIC SULFUR IN AIR POLLUTION. Science, 177(4054): 1099-1100, Sept. 22, 1972. 6 refs.

On a yearly basis, copper smelters are the dominant source of atmospheric sulfur compounds in and near Salt Lake City, Utah. Isotopic studies suggested that the next most important source is bacteriogenic sulfur released by anaerobes from river-bottom muds and marshes near Great Salt Lake. Bacteriogenic sulfur amounts to about 10,000 t/yr, or 10% of sulfur released annually by smelters. On a seasonal basis, the bacteriogenic source of sulfur may rival or exceed smelter contributions.

B. CONTROL METHODS

00163

Fink

ANTIPOLLUTION PROGRAM AND MEASUREMENT EQUIPMENT FOR CHECKING ON THE EFFECTIVENESS OF THIS PROGRAM IN THE ENTERPRISE. (Luftreinhaltung und Messtechnische Moglichkeiten Ihrer Innerbetrieblichen Uberwachung.) WIR-Die Werkzeitschrift der Duisburger Kupferhutte 10, (19) 15-21, Apr. 1965.

A general assessment of air pollution technologies required to set up an effective air control system is presented. The salient point of the paper centers around an alternating light photometer which the Duisburg Copper Smelting Plant has been successfully using. The concentration measurements made with this home-made photometer are based on the fact that gases reveal a radiation absorption in certain wave length ranges which depends on the gas concentration. By measuring this radiation absorption at a certain wave length or in a certain wave length range, the percentage of the harmful gas after calibration of the photometer with gas-air mixtures of varying concentrations can be indicated directly.

04567

D. J. Robertson

FILTRATION OF COPPER SMELTER GASES AT HUDSON BAY MINING AND SMELTING COMPANY, LIMITED. Can Mining Met. Bull. (Montreal) 53, 326-35, May 1960. (Presented at the Annual Western Meeting, Winnipeg, Canada, Sept. 1959.)

The gas filtration treatment which was installed in 1957, using glass cloth media to recover the dust burden is described. The associated problem of its treatment for recovery of zinc and cadmium is discussed. After a discussion of the plant and its development, the roaster fans, baghouse, and pneumatic dust conveying system are discussed.

06569

RESTRICTING DUST EMISSION FROM COPPER-ORE SMELTERS. (Staubauswurfbegrenzung Kupfererzhutten.) VDI (Verein Deutscher Ingenieure) Kommission Reinhaltung der Luft, Duesseldorf, Germany. (VDI 2101.) (Jan. 1960). 30 pp. Ger. (Tr.)

This specification treats the occurrence and reduction of dust emission in those units of copper-ore smelters which represent the principal sources of dust. The purposes are: to describe the installation creating dust; to characterize the influences leading to the creation of dust; to point out measures for the reduction of dust emission; to give indications on the selection of suitable dust-removal installations; and to establish guide lines on restricting permissible dust emission from new installations. The dust emitted from a copper-ore smelter represents a loss of valuable metal (copper, silver, gold). Consequently, the interest of copper-ore smelters in keeping these losses as low as possible is equally as great as the desire to guaranty purification of the air. The factors to be considered in specifying cloth filters, centrifugal separators, electrostatic precipitators, and stacks are reviewed.

07925

Beighton, J.

THE SPECIAL INDUSTRIAL PROCESSES. Roy. Soc. Health J. (London). 87(4):215-218, July-Aug. 1967. 2 refs. (London)

The air pollution problems of a group of industries which produce: sulfuric acid, nitric acid, petroleum and petrochemicals, iron and steel, copper, aluminum, gas, ceramics and electric power are reviewed. The basic technical approach is to avoid the formation of the emission by design of the process, then to require the treatment of any unavoidable emission, and finally to require adequate dispersal of any residual amount which has to be discharged. The legislation is designed to compromise between safeguarding of public health and amenities and providing for a realistic acceptance with adequate control of special processes. Although the loss of gases in the manufacture of sulfuric acid is limited to 2% of the sulfur burned, the loss from a contact acid plant with a 500-ton-per-day capacity may be considerable so that chimney heights as high as 450 ft may be required. Acid mist from contact plants burning sulfur is a special problem as it is difficult to control and its occurrence is unpredictable. There are two nitric acid plants in Britain equipped with catalytic tail-gas reduction units which should solve the problem of brown nitrous fume emission to the air. The use of special flares is required to control H2S and mercaptans emitted by oil refineries. In the steel industry the development of the Fuel-Oxygen-Scrap process is regarded as an alternative to the electric arc furnace. It is claimed that melting and refining can be carried out without exceeding a fume level of 0.05 grains per cu ft.

08562

Culhane, F. R.

PRODUCTION BAGHOUSES. Chem. Eng. Progr., 64(1):65-738 Jan. 1968. 1 ref.

Tests and field results are discussed for several baghouse installations associated with roasters, sintering machines, and reverberatory furnaces in the lead, zinc, and copper industries. Design considerations, such as air-to-cloth ratio and type of construction, are discussed. (Authors abstract)

11146

Anon.

SULPHUR. A HIDDEN ASSET IN SMELTER GASES. PART 4. Eng. Mining 169(8):59-66, Aug. 1968.

Smelter and converter gases and their contained sulfur are a specialized problem which may be turned into an asset for profit. The worldwide application of technology to this problem is reviewed Process description and applications are discussed.

13026

Minoura, J.

ON THE NOVEL METHOD OF COPPER REFINING WITH THE AIM OF PREVENTION OF POLLUTION BY MINERALS. (Kogai-boshi o mokuteki toshita atarashii doseiren-ho ni tsuite). Text in Japanese. Netsu Kanri (Heat Engineering, Tokyo), 21(5):12-16, May 1969.

A novel copper refining method, using 'The Auto-blast furnace' developed in Finland, is becoming predominant in Japan. It has three notable advantages: (1) easy re-absorption of SO2 by means of compressed flue gas; (2) low cost, because of less investment for the facilities and equipment for pollution prevention; and (3) production of more by-product H2SO4. The refining process can be briefly summarized as follows: (1) preliminary process, in which the minerals are dried; (2) melting and refining; and (3) handling of flue gas. A significant aspect of this method is that controlling the temperature and pressure within the furnace and cyclone enables almost perfect re- absorption of SO2 emitted and production of a considerable amount of H2SO4.

14638

Ushakov, K. I., O. V. Nadinskaya, I. G. Dobrochiver, and S. P. Zharova

REDUCTION OF SULFUR DIOXIDE BY COKE UNDER CONDITIONS APPLICABLE TO COPPER-SULFUR SMELTING. (Vosstanovleniye sernistogo gaza koksom primentil'no k usloviyam medno-sernoy plavki). Text in Russian. Sb. Nauchn. Tr., Gos. Nauchn.- Issied. Inst. Tsvetn. Metal., no. 26:168-177, 1967. 16 refs.

A laboratory study of the reduction of sulfur dioxide by coke was carried out for the purpose of making separate determinations of SO2, H2S, CO, CO2, COS, and CS2 contents in the gas phase using gas-liquid chromatography. These studies were directed toward optimizing the production of elemental sulfur during copper-sulfur smelting. Experiments were made with a charge containing 10% coke and 90% quartz at 100-deg intervals from 700 to 1200 C. The coke contained 74% carbon and 11.5% ash; its porosity was 32.5%, and specific gravity was 1.67. The incoming gas mixture was 10% SO2 and 90% N2; contact time was 4 sec. Additional tests were made at 1200 C with a charge of 100% coke for various SO2 contents in the starting gas (4.4-11.9%) and with various contact times 4.4-5.0 sec). Reduction of SO2 began at 800 C and increased with temperature and the amount of coke present, reaching 83% at 1200 C with 10% coke, and 92.1% with 100% coke. Increasing contact time above 4 sec had practically no effect on the degree of reduction. It is recommended that the SO2 content of the furnace gas be 2.5-3.0% with an optimized coke content.

14642

IMPROVEMENTS RELATING TO THE RECOVERY OF SULPHUR DIOXIDE. (Electrolytic Refining and Smelting Co. of Australia, Pty. Ltd., Port Kembia) Australian Pat. 164,272. 5p., July 22, 1955. (Appl. Jan. 27, 1953, 9 claims).

A method is described for recovering sulfur dioxide contained in low concentrations from metallurgical and industrial flue gases. The apparatus used in carrying out the method includes a vertical, cyclindrical reaction tower containing a porous bed of reactive material, preferably metallic copper and/or a copper alloy or copper ore, in the form of wire, thin strips, or shavings. A solution of water and ammonia is supplied to the tower at a controlled rate; its strength is progressively increased by recirculating it through the porous bed. When gas is circulated upward through the bed, sulfur dioxide and the reactive material are dissolved in the liquid. Sulfur is recovered in the form of metallic salts or sulfuric acid.

15304

Gerlach, J., H. G. Kleist, and K. Mager

THE SPEED OF PHASE TRANSITION OF GASEOUS SULFUR DIOXIDE IN LIQUID COPPER. (Die Geschwindigkeit des Phasenuebergangs von gasfoermigem Schwefeldioxid in fluessiges Kupfer). Text in German. Metall. (Berlin), 19(11):1163-1167, 1965. 22 refs.

Experiments for determining the solution speed of sulfur dioxide in a copper melt were conducted in a vacuum apparatus consisting of a bulb-shaped reaction chamber. A certain amount of gaseous SO2 is passed over liquid copper. The SO2 quantity retained by the liquid copper can be determined by measuring the pressure drop in the gas phase. From the results, the diffusion constant for sulfur was computed to be 0.06 cm/sec and 0.013 cm/sec for oxygen. In practical terms, the results of these experiments show that in the copper refining process, all the sulfur from the SO2 discharged by the furnace is retained by the copper bath. If the furnace is fired with heavy fuel oil, the copper bath retains 18 g S/t Cu within five minutes. Even if the phase boundary is 0.005 cm thick and the sulfur enters by diffusion only, the sulfur content of the copper bath increases in 2 hrs by 10 g/t Cu. The collision efficiency was found to be 0.001.

1671

BAG LIFE EXTENDED AT COPPER REFINERY. Air Eng., 11(1):18-19, Jan. 1969.

Conversion from glass fiber fabric to a filter fabric made of DuPont's high temperature fiber, Nomex nylon has increased the effective life of copper refinery filters by at least a factor of 14. The requirement was for a material which could withstand continuous exposure to 350 F, the abrasion of an inert oxide dust, and the flexing resulting from periodic shaking to drop the accumulated cake from the interior of the bags to the collecting bins below.

21309

Argenbright, L. P. and Bennett Preble

SO2 FROM SMELTERS: THREE PROCESSES FORM AN OVERVIEW OF RECOVERY COSTS. Environ. Sci. Technol., 4(7):554-561, July 1970.

About 2.2 million long tons per year of sulfur is contained in the sulfur oxide gases generated in the operation of copper, zinc, and lead smelters in the western United States. Nearly 23% of this is recovered, mostly as sulfuric acid. A study was made to identify and evaluate the technological and economic problems associated with controlling the sulfur oxide emissions of these smelting operations. Three processes for control and by-product recovery were considered: the contact sulfuric acid process, the Cominco absorption process, and the ASARCO reduction process. All three are adversely affected by the low percentage of sulfur in the exhaust gases. Similarly, all are limited in optimum size, since the capital investment for larger operations off-sets the reduction in operating cost. Of the three processes considered, the contact sulfuric acid process is the least costly, both in terms of initial cost and operating cost.

22930

Bulgakov, M. V.

AN EXPERIMENT IN CREATING PROTECTIVE PLANTINGS IN THE CITY OF KRASNOURAL'SK. In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation; Resistance and Susceptibility of Different Plant Species in Various Habitats, In Relation to Plant Utilization for Shelter Belts and as Biological Indicators. M. Y. Nuttonson (ed.), vol. 2, Silver Spring, Md., American Institute of Crop Ecology, 1969, p. 79-84. (Also: Akad. Nauk SSSR Ural. Filial. Ural. Gos. Univ.

Im. A. M. Gor'kogo. Okhrana prirody na Urale (Sverdlovsk), vol. 4:189,195, 1964.)

Krasnoural'sk is a large center of copper smelting and chemical industry in the Central Urals. Large amounts of sulfur dioxide and fluorine, which are harmful to vegetation and man, are discharged to the atmosphere. The local natural forest was destroyed by SO2, and as a result the city became unattractive and dusty. An arboreal nursery was established to aid in the selection of trees and shrubs adapted to local environmental conditions. An assortment of gas-resistant species for city plantings was developed, including poplar, birch, cedar, larch, maple, elm, Siberian pea shrub, elder, dogwood, sweetbrier, and others. Siberian pea shrubs from the local nursery and from another nursery were planted in a city park. The leaves on the plants from the local nursery remained normal in appearance, while those from the other nursery were severely damaged by SO2. This confirms the fact that the trees and shrubs for gas-polluted areas should be exclusively local, raised in the same noxious medium where they are to continue their growth. If frost-resistance is also desired, the plants should be raised under rigorous, spartan conditions. The establishment of parks and plazas, and the great number of trees and shrubs along the streets have made the air of the city cleaner and resulted in a milder microclimate.

23032

Hall, William A.

PROCESS OF PREVENTING THE ESCAPE OF SULFUR DIOXID IN SMELTING SULFID ORES. (Assignee Not Given.) U. S. Pat. 1,134,846. 5p., April 6, 1915. 3 refs. (Appl. June 30, 1913, 9 claims).

A process is described for the recovery in elemental and commercial form of the sulfur evolved from pyrites in the operation of smelting copper, and for preventing the discharge of noxious sulfur dioxide fumes from the furnace into the atmosphere. A reducing gas flame is introduced into the upper level of the furnace, capable of reducing a part at least of the sulfur dioxide to elemental sulfur, while preventing the access of air to oxidize any considerable quantity of the elemental sulfur. The preferred temperature to be maintained may be about 700 C. Under certain conditions, such as the employment of a reducing gas poor in hydrogen, a certain amount of steam or water vapor is admitted along with the reducing gas.

23378

Potts, H. R. and E. G. Lawford

RECOVERY OF SULPHUR FROM SMELTER GASES BY THE ORKLA PROCESS AT RIO TINTO. Trans. Inst. Mining Met., vol. 58:427-516, 1949. 8 refs.

A process which recovers sulfur from copper-smelting fumes is described. The process operates by containing the sulfur dioxide produced in the combustion of the ore in a closed furnace, thus preventing the SO2 from being burned itself in atmospheric air. Then, the SO2 is sent through a column of solid carbon, where a reduction reaction separates the sulfur out as a vapor. Upon cooling, the crude solid sulfur can be removed. The process as described is used at the Rio Tinto mine in Brazil, but it originated at the Orkla Co. in Norway, where it got its name. The Rio Tinto plant operation is described in detail. Catalysts are not used because the ore contains substantial amounts of arsenic, which greatly complicates catalytic activity. Improvements needed in the process include better oxidation of the ore and greater reduction of SO2, possibly by going to higher operating temperatures.

23939

Nagibin, V. D.

SMELTING CONCENTRATES IN CONVERTERS AND PRODUCTION OF SULFUR DIOXIDE FOR SULFURIC ACID MANUFACTURE. Soviet J. Non-Ferrous Metals (English translation from Russian of: Tsvetn. Metal.), vol. 9(10):39-42, Oct. 1968.

Industrial tests were performed on the converter smelting of copper matte in an air blast enriched with up to 24-27% oxygen. The output capacity of converters increased proportionally to the percentage of oxygen in a blast. The temperature of the molten charge in converters increased sharply as a result of the heat of exothermic reactions; this permitted the processing of cold additions in the form of ore, concentrate, and other copper- containing materials. Concentrations of sulfur dioxide in the waste gases of the converter increased by 1.5-2.5% (in absolute value), varying during the second blowing period by 5-10%. The operating regime of the converters decreased markedly when enriched blasts were used during the first and second blowing stages. On the basis of these findings, programs were developed for the smelting of pelletized copper concentrates and for the production of sulfuric acid from converter waste gases alone. The latter process is based on a starting concentration of about 4% SO2 in converter waste gases fed to a contact-reaction vessel and on special conditions for matte blowing. At least two converters are continually on blast, the blast consumption of each varying between 30,000 to 45,000 cu m/hr. Before being passed to the sulfuric acid production plant, the exhaust gases are pressure fed by a blower to electrostatic dust separators. An automatic switching system for changing the direction of the gases from the sulfuric acid units to stack exhaust makes it possible to stabilize the content of sulfur dioxide being shipped to the former.

24724

Lamoreaux, W. F.

THE FELD SCRUBBER FOR CLEANING METALLURGICAL SMOKE. Eng. Mining J., 113(5):198-207, 1922.

A description is provided of a spray tower counterflow scrubber use to clean the flue gas of a copper smelter. Unique application of this unit is that the particulates recovered are reprocessed for their zinc content and the gas is processed for elemental sulfur. A brief history is given of the failures experienced with dry centrifugal cleaning, wet baffle cleaning, bag filters, and electrostatic precipitation. The Feld scrubber with which success was finally achieved is a seven layer system in which primary washing is performed in the lower three chambers, separation in middle section, and cooling and dehumidification is performed in the upper three chambers, although this may be varied at the will of the operator. Wash water is admitted at the selected level and atomized by the rotary motion of the perforated central cones and again by impact with the outer wall. Rim speed of the cones is approximately 2000 fpm. Gas is admitted at the bottom and passes upward through the mist of wash water. Capacity of the unit is 200,000 cfh with wash water recirculated at a rate of 65 gpm. During initial operation some SO2 is lost by disolving into the wash water, but when the water becomes saturated, effectively all of the SO2 is available to the sulfur reduction unit, and the saturated wash water apparently does not inhibit the particulate recovery. Purity of the reduced flowers of sulfur is 99.2%. The scrubber operates on a 24 hour day, seven days a week basis, requiring only lubrication to keep it in operation which can be applied without stopping the equipment.

25275

Nilsson, Folke and Bengt Rudling

AIR POLLUTION CONTROL AT THE BOLIDEN COPPER AND LEAD SMELTING PLANT, ROENNSKAERSVERKEN, SWEDEN. Preprint, International Union of Air Pollution Prevention Associations, 36p., 1970. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper SU-24D.)

Factors considered when the Boliden Company's copper and lead smelter was erected in Sweden in 1928-1930 are reviewed. Built for smelting copper-arsenopyrite ore from the Boliden mine, the smelter was placed on a peninsula at the Bothnian Gulf. To utilize excess sulfur in the ore as pyrite and thereby reduce the sulfur dioxide emission by about 50%, the ore was concentrated. After World War II a sulfuric acid plant took care of the roaster gases and ten years later the production was increased three-fold by further SO2-utilization. Hereafter no effect can be seen on forest, crop, or garden. The concentration of SO2 in ambient air around the the smelter is far beneath the official limit. The production of liquid SO2 for the paper and pulp industry will now make it possible to utilize over 90% of the SO2. The SO2-recovery is made by absorption in water. This process is economical when a good supply of cold water for cooling and inexpensive surplus steam is available. Along with diversified and increased production, dust cleaning has been extended and modernized. The results of these activities have been followed up by medical studies of the population. (Author abstract modified)

26142

Leaver, Edmund S. and R. V. Thurston

FERRIC SULPHATE AND SULPHURIC ACID FROM SULPHUR DIOXIDE AND AIR. Bureau of Mines, Washington, D. C., Rept. of Investigations 2556, 7p., Dec 1923. 2 refs.

During the development of a sulfur dioxide leaching process for treating 'mixed' copper ores, the pulp from the treatment of roaste cupriferous pyrite with sulfur dioxide gases and water showed an unexpected amount of sulfuric acid. This was due to iron in the solution; the iron tended to oxidize to the ferric state if the concentration of sulfur dioxide in the roaster gases did not rise above a certain figure. The percentage of iron present was sufficient to cause an entirely different set of conditions from those of the original sulfur dioxide leaching process and to promise a much wider application of the general idea. It is possible that ferric sulfate and sulfuric acid solutions, prepared from a cheap form of sulfur dioxde, will be utilizable for the treatment of all oxidized copper minerals and for the recovery of copper from concentrator tailing where the copper is present both in oxidized minerals and in sulfides or native state which can be attacked by ferric sulfite. Preparation of the solutions is reviewed. (Author introduction modified)

26589

POLLUTION CONTROL IN WORCRA SMELTING. Mining Mag. (London), 124(1):5, 7, Jan. 1971.

The Worcra copper-smelting process is claimed to make a significant contribution to air pollution control since the furnace delivers a steady stream of gas containing approximately 10% sulfur dioxide. Because of this high concentration, the gas volume/unit of the contained sulfur is relatively small and economies can be achieved in the capital and operating cost of gas cleaning and purification equipment associated with sulfuric acid recovery. Pilot plant observations indicate that the solids content of gas emission from the Worcra furnace would be 2-6% of the weight of the feed material. The nature of the gas from the furnace is also considered suitable for the recovery of liquid sulfur or elemental sulfur.

27597

Semrau, Konrad T.

CONTROL OF SULFUR OXIDE EMISSIONS FROM PRIMARY COPPER, LEAD, AND ZINC SMELTERS--A REVIEW. Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 39p., 1970. 140 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 14-18, 1970, Paper 70-97.)

The methods of control of sulfur dioxide emissions from primary copper, lead, and zinc smelters are reviewed. The principal barrier to control is economical rather than technical. The processes of copper, lead, and zinc smelting are described. Method for control and useful recovery of sulfur oxide emissions are placed into 3 categories: systems producing sulfuric acid; systems producing concentrated sulfur dioxide, either for use as such or as an intermediate in production of some other materials, such as sulfuric acid or elemental sulfur; and systems producing elemental sulfur. Processes described include a conventional gas cleaning and conditioning system for a sulfuric acid plant consisting of scrubbing towers and a wet-type electrostatic precipitator, the Asarco DMA absorption system, the Cominco ammonia absorption system the Lurgi Sulfacid process, the Monsanto Cat-Ox process, the Boliden process, the Asarco Brimstone process, the TGS process, and the Claus process.

28595

Semrau, Konrad T.

FEASIBILITY STUDY OF NEW SULFUR OXIDE CONTROL PROCESSES FOR APPLICATION TO SMELTERS AND POWER PLANTS. PART I: THE MONSANTO CAT-OX PROCESS FOR APPLICATION TO SMELTER GASES. (FINAL REPORT). Stanford Research Inst., Menlo Park, Calif., NAPCA Contract CPA 22-69-78, SRI Proj. PMU-7923, 54p., 1969 (?). 20 refs. NTIS: PB 197166

The Monsanto Cat-Ox system for sulfur oxides recovery is essentially an adaptation of the contact process for sulfuric acid manufacture. The gas containing both SO2 and oxygen is passed through a fixed bed of catalyst at an appropriate temperature, and most of the SO2 is oxidized to SO3. The gas is then passed through an absorption tower, where the SO3 is absorbed in recirculated sulfuric acid. Though developed primarily for use with power plant flue gases, the Cat-Ox system can be used on dilut gas streams (such as smelter gases) containing 2% or less SO2. In the present study, cost estimates were obtained for application of the Cat-Ox system to hypothetical copper and zinc smelters of varying sizes and producing 2% and less SO2. Even with the richest of the gases, the acid production cost would exceed $ll/ton, making the acid noncompetitive with that from alternative available sources. For gases containing less than 2% SO2, acid production costs rise rapidly with decrease in SO2 concentration. Plant size is an additional but much less important factor in acid-production cost.

29199

TWO DIRECT SMELTING PROCESSES DESIGNED FOR POLLUTION CONTROL IN COPPER PLANTS. Eng. Mining J., 172(4):129, April 1971. 1 ref.

Two direct smelting processes for treating copper concentrates which telescope conventional reverb-converter treatment into

one unit are being developed to control pollution. In the Noranda Mines Ltd. process, concentrates and feed are introduced in one end of the reactor which is similar in cross-section to a Peirce-Smith converter. Smelting takes place at the feed end, while matte and slag flows are controlled as they move slowly to tapping ports. Oxidizing gas is introduced into the matte to oxidize the iron sulfide. Continued injection of the gas into the resulting white metal gradually oxidizes the cupric sulfide to metallic copper. Advantages claimed for the Noranda process include ready recovery of sulfur for the production of sulfuric acid, savings in fuel costs, lower labor requirements, and an improved plant environment for workers. In the WORCRA continuous bath-smelting process, invented at Conzinc Riotinto of Australia Ltd., metal is produced directly from concentrates in one unit. Most of the exothermic oxidation reactions are generated and continue in the liquid bath, while turbulence is generated in the smelting and converting zones by lance-injected oxygen-containing gas. Slag moves countercurrent to matte and metal flow in the converting zone. Furnace gases rich in SO2 can be cooled and cleaned for waste heat utilization and production of sulfuric acid; or because of low oxygen content, the gases can be used to produce elemental sulfur.

29327

Bridgstock, Guy

HOW TO LIMIT SO2 EMISSIONS WITH THE FLASH SMELTING PROCESS. Eng. Mining J., 172(4):120-123, April 1971. 2 refs. (Presented at the American Institute of Chemical Engineers Meeting, Chicago, Ill., Dec. 1970.)

While most off-gases from copper smelting operations have a concentration of sulfur dioxide so low as to preclude their use in processes which would permit the recovery of SO2, the Flash Smelting Process can produce a high SO2 content gas stream that can be further treated for SO2 removal by existing chemical methods. Developed by Outokumpu Oy in Finland, flash smelting consists of mixing finely divided dried concentrates with preheated air at the top of the reaction shaft of the furnace in a specially designed concentrate burner. The heat energy released by exothermic reactions of oxidation of the sulfur and iron in the concentrates performs the smelting. These oxidizing reactions continue as the suspended concentrates descend in the shaft of the furnace. The smelted material settles in a molten state in the settler section at the bottom of the furnace as matte and slag while SO2-bearing gases flow out an uptake shaft near the opposite end of the furnace into a heat and dust recovery system. Commercial experience with flash smelting and its advantages are indicated.

29622

Argenbright, Lee P.

SMELTER POLLUTION CONTROL--FACTS AND PROBLEMS. Mining Congr. J., 57(5):24-28, May 1971.

Copper smelters produce the largest total volume of the nonferrous metals and have some of the greatest problems in recovery of sulfur oxides. The major sulfur recovery from smelters is in the form of sulfuric acid at the present time, but the problem lies in the lack of consumers for the acid within practical access of the smelting facilities. It has been suggested that sulfur oxide gases be reacted with lime to produce a disposable material which is primarily gypsum, an insoluble and relatively inert product. Unfortunately, the best lime for such use will not be pure and some soluble substances will also be produced. With the advent of rainfall, a stream pollution problem of substantial proportions may exist. There are several proven processes for reducing sulfur oxides to sulfur from high concentration gases. To take advantage of these processes there has been and is continuing, a considerable effort to concentrate weak gases to suitable strength. Implementation of any new control process requires the very minimum time of five years. System capability and reliability must be considered, as well as economic factors. In the future, smelters will tend to use continuous rather than batch processes.

30121

Dunn, Richard L.

TFE-FLUOROCARBON FIBER FILTER BAGS--IT COSTS MORE TO GO FIRST CLASS. Plant Eng., 25(11):56-57, May 27, 1971.

Typical properties of TFE-fluorocarbon (teflon) filters are summarized and discussed. Among the properties that would seem to make the filters ideal for baghouse use are their resistance to chemicals and high temperatures and their cleaning ease. In practice, the application of the filters is limited by their high initial cost. Their use appears economically justified for copper smelters, clay manufacturing operations, terphthalic acid production, and carbon black collection. Other companies are obtaining some of the benefits of fluorocarbon fiber by using cuffs of the material on the bottoms of glass fiber bags.

31826

Joyce, R. S., R. T. Lynch, R. F. Sutt, and G. S. Tobias

EFFECTIVE RECOVERY OF DILUTE SO2. Preprint, American Institute of Chemical Engineers, New York, N. Y. and Inst. Mexicano de Ingenieros Quimicos, Mexico City, 24p., 1970. 6 refs. (Presented at the American Institute of Chemical Engineers and the Instituto de Mexico Ingenieros Quimicos, Joint Meeting, 3rd, Denver, Colo., Aug. 30-Sept. 2, 1970.)

The feasibility of a continuous process for the carbon catalyzed oxidation of sulfur dioxide in gas streams was demonstrated on a bench scale. The product is a sulfuric acid solution up to 15% by weight. In a series of factorial experiments controlling variables in the process were the oxygen/SO2 mol ratio and gas contact time. Temperature also has an effect on the reaction rate although this cannot always be controlled. The relationship of the percent of SO2 oxidation to the O2/SO2 ratio and contact time was established, and optimum operating conditions were predicted. Advantages of the process were high conversion efficiencies for dilute SO2 streams, catalyst longevity, and simplicity. Using the bench scale data, economic projections for two potential applications were made. These applications were the reduction of SO2 emissions from copper smelting reverberatory furnaces and abatement of SO2 in stack gas from contact sulfuric acid plants. In both cases the projection showed the carbon process to be economically feasible and capable of significant SO2 abatement. (Author summary)

32237

Bridgstock, Guy and Rauno Seeste

ENVIRONMENTAL CONTROL THROUGH THE USE OF FLASH SMELTING. Preprint, American Inst. of Chemical Engineers, New York, 6p., 1970. (Presented at the American Institute of Chemical Engineers, Annual Meeting, 63rd, Chicago, Ill., Dec. 1970.)

The problem of atmospheric pollution caused by sulfur dioxide in furnace gases resulting from the smelting of sulfide copper ores and concentrates is reviewed. A recently developed flash smelting process reduces the SO2 effluent by increasing the SO2 content of the process off-gases to enable the significant recovery of sulfuric acid or sulfur. Flash smelting, which com-

bines in one operation the roasting and smelting methods for treating sulfide copper concentrates, consists of mixing finely dried concentrates with preheated air at the top of the reaction shaft of the flash furnace in a specially designed concentrate burner. The smelting, concentrate preparation, formation of matte and slag disposition, gas and dust control, matte tapping, converting, fuel economics, and high SO2 content of the gas stream are individually treated. The gas, treated in contact acid plants, produces sulfuric acid and reduces atmospheric pollution from SO2 to a negligible level. A comparison of the reverbatory smelting and flash smelting processes indicates that although initial installation costs of the flash smelting process are higher, they are offset by the lower operating costs and higher metal recovery.

32319

Konopka, A. P.

PARTICULATE CONTROL TECHNOLOGY IN PRIMARY NON-FERROUS SMELTING. Preprint, American Inst. of Chemical Engineers and Inst. Mexicano de Ingenieros Quimicos, 10p., 1970. 9 refs. (Presented at the American Institute of Chemical Engineers and Institute Mexicano de Ingenieros Quimicos Joint Meeting, 3rd, 0Denver, Colo., Sept. 1970.)

The sources and nature of particulate emissions and control technology in the primary smelting of aluminum, copper, lead, and zinc are described. The high dust concentrations generated by bauxite drying and alumina calcining frequently require multicyclones for preliminary collection, followed by electrostatic precipitation. Installed costs for the combined system are $4.60-$2.30/CFM, at 99+% collection efficiencies. Electrolytic aluminum reduction cells pose a more complicated emission problem: moderate-energy wet scrubbers, glass filter bags, or flushed precipitator installations are used. Representative installed costs for the three methods are $3.00/CFM, $2.00/CFM, and $2.00/CFM, respectively. Dry electrostatic precipitators, preceded by mechanical collectors, are universally applied in copper smelting. Installation costs for the combined equipment are $6.00/CFM for 50,000 CFM flows and $3.00/CFM for 2,000,000 CFM flows. Large lead blast furnaces employ electrostatic precipitators, smaller units use fabric filters. Installation costs of vertical flow pipe-type precipitators in the 100,000 CFM range are $6.00/CFM. Continuous baghouses for smaller volumes cost $5.00/CFM installed. Horizontal flow plate precipitators are used on new zinc sintering machines. Mild-steel construction is common, and installed costs for 50,000 CFM collectors are $3.50/CFM. Emissions from flash roasting of zinc ore are also controlled by plate-type precipitators of mild steel construction. Installed costs are $3.50/CFM.

32760

Schulz, Ulrich and Ulf Richter

THE INFLUENCE OF TECHNOLOGICAL PARAMETER ON THE COLLECTION EFFICIENCY OF ELECTROSTATIC PRECIPITATORS IN NON-FERROUS METALLURGY. (Einfluss technologischer Parameter auf den Abscheidegrad von Elektrofiltern in der NE-Metallurgie). Text in German. Neue Huette, 16(7):385-390, July 1971. 13 refs.

Experiments were conducted with a hot gas electrostatic precipitator to determine efficient design criteria for application to the non-ferrous metallurgical industry. A sample flow was drawn through the precipitator from waste gases coming from copper, tin, zinc, and lead furnaces. Dust which had remained in the gas after passage through the precipitator was removed with a glass fiber reinforced asbestos paper filter. Efficiency measurements, resistance determinations, and theoretical considerations revealed that the filter temperature and water content of the gases influence the collection efficiency by relationships which are controlled by the specific electric resistivity of dust. In the case of dusts with a resistivity of less than 10 to th 10th power ohm/cm, temperature and dew point influence the collection efficiency via the breakdown voltage and the gas viscosity, regardless of the dust resistivity.

32888

CITRIC ACID SWALLOWS SO2. (Citronensaeure schluckt SO2). Text in German. Chem. Ind. (Duesseldorf), 23(9):624, Sept. 1971.

A new method of desulfurization with citric acid, based on the reaction of sulfur dioxide in the waste gas in aqueous solution with the citrate ions under formation of a bisulfite-citrate complex is examined. The complex is decomposed again by hydrogen sulfide; sulfur is separated, and the citrate ions are liberated again. Approximately one third of the liberated ulfur is converted to hydrogen sulfide and used for liberation of the sulfur from the bisulfite citrate complex. Constructon costs fr cening 285,000 cu ft/min of SO2-containing waste gas from a copper plant with an annual throughput of 100,000 short tons would amount to 13 million dollars. The SO2 content of the waste gases is about 2%. At a sulfur yield of 95%, about 114,000 tons sulfur/year would be obtained.

33157

Belousova, A. E., L. I. Mekler, A. A. Egizarov, and E. A. Simkin

HYDROMETALLURGICAL TREATMENT OF DUSTS FROM DRY ELECTROFILTERS AT COPPER SMELTERS. Soviet J. Non-Ferrous Metals (English translation from Russian of: Tsvetn. Metal.), 10(6):37-39, June 1969. 1 ref.

A technology was developed for treating the dusts from dry electrofilters at copper smelters for the production of a sulfide-lead concentrate, a zinc-cadmium intermediate product, a copper-calcium cake, and ammonium perrhenate, thus increasing the comprehensive use of raw material. By sulfidization of the lead cakes, a concentrate which contains over 60% Pb can be obtained. Copper is extracted in the form of an intermediate product, containing 10-15% Cu with a final recovery of about 70%. Rhenium is sorbed from solutions with the subsequent obtainment of ammonium perrhenate and about a 90% recovery. Through precipitation with soda, it is possible to separate from solutions a zinc-cadmium intermediate product which contains 40-45% Zn, 0.7-0.9% Cd, and to 0.008% thallium. (Author conclusion)

34944

Milliken, Clint L.

COPPER SMELTER DESIGN FOR THE SEVENTIES. Preprint, Kaiser Engineers, Oakland, Calif., Metallurgical Projects Dept., 6p., 1970 (?). 5 refs.

The copper smelter will require drastic design changes to meet the stiffening local and national environmental codes with respect to sulfur dioxide emission. The industry has been surveyed to determine an optimum smelter design based on a high concentration of effluents for the economical removal of SO2 from waste gases. As described herein, the optimum concept involves a combination of two modified processes: a variance of the Outokumpu-type flash furnace, followed by a stationary, top-blown converter. Two significant features of this combination are the continuous overflow of slag and the continu-

ous underflow of very high grade matte -- essentially white metal. This means that the slag-blowing operation is virtually completed in the flash furnace, permitting the use of a top-blown converter for the copper blow. (Author abstract modified)

35295

Dayton, Stan

WET SCRUBBING OF WEAK SO2 GETS A TRIAL AT NEW MCGILL PILOT PLANT. Eng. Mining J., 172(12):66-68, Dec. 1971.

Preliminary results are reported for a pilot plant limestone scrubbing system installed at a copper smelter. Designed to handle both dilute reverberatory gas (0.2 to one percent sulfur dioxide) and concentrated converter gas (four percent or more SO2), the pilot plant uses ground wet limestone to fix sulfur as a calcium sulfate. Primary reactors are a venturi scrubber and a turbulent contact absorber (TCA). Prior to limestone scrubbing, smelter gas is cooled and cleaned with a water wash in a cooler scrubber. All low-magnesium limestones tested appear equally reactive and, in general, more reactive than high-magnesium limestone. About eight pounds of limestone are required per pound of sulfur treated. This raises a problem for smelters at a distance from a concentrator, since they have no readily available tailing pond. Operating on 0.4% SO2 gas, sulfur recovery efficiency is 70%. On a gas feed of 0.7% SO2, the conversion factor is only 50%. Neither figure would permit an existing smelter with an acid plant for converter gas and a limestone scrubbing unit taking gas from a tightly hooded reverberatory to achieve the 90% sulfur recovery standard legislated by several states.

35296

Ichijo, Michio

JAPAN TODAY: POLLUTION-FREE METALLURGY. Mining Mag. (London), 125(5):471-474, Nov. 1971. 10 refs.

A pollution-free process for recovery of various metals from Kuroko ore is described. The ore is first separated by a flotation process to produce copper, lead, zinc, iron, and slime bulk concentrates, plus tailings. The copper concentrate is then treated by a dry method for extraction of crude copper. Iron concentrate is treated by the Kohwa process to obtain hematite pellets. Lead and zinc dust from the copper concentrate and vaporized copper, lead, and zinc chlorides from the iron concentrate are treated in a gas-absorbing neutralization tank and then separated from the transparent solution by precipitation. Lead and zinc concentrates and slime bulk concentrates are oxidized and leached with ferric chloride solution, separating the precipitate from the transparent solution. Sulfur is precipitated as elemental sulfur, then the leached residue is recycled to the flotation process. The transparent solution, after leaching with ferric chloride, contains copper, lead, zinc, and other metallic ions. High purity metals are obtained by amalgam phase exchange in combination with amalgam electrolysis.

37750

Schulz, Ulrich and Ulf Richter

INFLUENCE OF TECHNOLOGICAL FACTORS ON THE DEGREE OF SEPARATION OF ELECTRIC FILTERS IN NON-FERROUS METALLURGY. (Einfluss technologischer Parameter auf den Abscheidegrad von Elektrofiltern in der NE-Metallurgie). Text in German. Neue Huette, 16(7):385-390, July 1971. 13 refs.

The flying dust generated in non-ferrous metallurgical furnaces is mostly composed of oxidized particles of zinc, lead, tin, antimony, and arsenic. Sheet-type filters and electrostatic precipitators are used for removal and recovery of these dust types. Due to the generally high specific electric resistance of the dust, the process can be carried out effectively only by adhering to certain values of precipitation temperature and water content of the gas phase. To establish design parameters for the construction of precipitators for the non-ferrous metal industry, the precipitation rate of waste gases derived from various metallurgical furnaces for copper, zinc, tin, and lead was measured by a laboratory-type electrostatic precipitator. The influence of precipitation temperature and water content of the gas phase on the precipitation rate was investigated. The results of measurements of precipitation rates and electric resistance of the separated dust material, in combination with theoretical considerations, lead to the conclusion that with dust of a specific electric resistance of less than 10 to the 10th ohm cm, the precipitation rate is influenced by temperature, dew point of gas, viscosity of gas, and voltage of electric field, independent of the specific electric resistance of the dust. Above 10 to the 10th and up to 10 to the 11th ohm cm, the precipitation rate is related to the specific electric resistance of the dust.

38648

ASARCO DEDICATES HAYDEN ACID PLANT. Mining Congr. J., 58(3):28-29, March 1972.

The American Smelting and Refining Company s new $17 million sulfuric acid plant at its Hayden, Arizona, copper smelter cuts sulfur dioxide emissions from the smelter in half and also removes dust and particulate matter from the converter smoke stream. Asarco s new plant is the first in the United States to employ the Chemiebau-Zieren process. The process starts at the Hayden smelter s five converters, where sulfur is removed from the copper by converting it into sulfur dioxide through oxidation. The product of this operation is blister copper. Gas leaving each converter is cooled in a water-cooled hood; following this, copper-rich dust drops out of the gas stream and is returned to the smelter. Flues 5 ft in diameter leading out of the converters direct the gas flow into cyclone banks and, from the cyclone banks, the gases discharge into a common header for four 3-stage Chemiebau hot-gas electrostatic precipitators. The clean gas, still relatively hot, then passes through a weak acid tower where the minor amounts of sulfur trioxide formed in the converters are made into a weak sulfuric acid. Remaining gas, mostly sulfur dioxide, is cooled and washed in another series of towers. Four parallel two-stage Chemiebau wet-gas electrostatic mist precipitators take out any remaining dust and particulates. Acidic scrubber water plus the weak acid is used later to make a salable 75% acid. Moisture-laden sulfur dioxide gas is dried in a tower, irrigated with 94% sulfuric acid, and sent by two 2500 hp single-stage centrifugal blowers into the contact plant.

38823

Bender, Rene J.

AIR POLLUTION CONTROL: ITS IMPACT ON THE METAL INDUSTRIES. Power, 116(4):56-60, April 1972. 1 ref.

While the control of air pollution can be accomplished readily in a reasonable period of time by the larger steel, aluminum, and nickel producers, and with a little greater effort by the largest copper and copper-derivative companies, it can have disastrous consequences upon small, low-capital enterprises. One of the most difficult problems in the steel industry is to eliminate emissions while loading and unloading coke ovens.

The basic oxygen process, bag houses, and other steps being taken by the steel companies to modernize their equipment to maintain a clean environment are mentioned. Tall chimneys and electrostatic precipitators are being utilized by the nickel industry, while a new molten aluminum fluxing process and a chemically coated filter-bag system are under development for the aluminum industry. The effect of strict emission regulations on the copper industry and the plight of small foundries are mentioned. Costs for pollution cleanup are given.

39456

Drobot, W., S. Finkler, and D. R. Whitlock

EVALUATION OF THE ATOMICS INTERNATIONAL MOLTEN CARBONATE PROCESS. Singmaster and Breyer, New York, N. Y., National Air Pollution Control Administration Contract CPA 70-76, 207p., Nov. 30, 1970. 11 refs. NTIS: PB 207190

The Molten Carbonate Process for the removal of sulfur oxides from power plant stack gases was evaluated for the base case of an 800 MW plant operating with coal containing 3% sulfur and for the alternate cases of 400 and 1000 MW stations burning fuel with 1-6% sulfur. In essence, the process consists of scrubbing flue gas with a molten mixture of lithium, potassium, and sodium carbonates, followed by the successive conversion of the recovered oxides to sulfides and hydrogen sulfide. The final step, not included in the evaluation, is the production of elemental sulfur from the H2S gas by the Claus process. The evaluation of the base case resulted in an estimated capital cost of $13.4 million to achieve a 95% reduction in sulfur oxide emissions. The capital cost was equivalent to approximately $17/KW of station capacity. This capital cost was equivalent to approximately $17/KW of station capacity. The estimated annual operating cost was about 0.9 mills/station KWH. Operating unit costs at 800 and 1000 MW plant capacity were essentially unchanged for a given coal sulfur content. The unit costs at 400 MW capacity increased significantly. Preliminary cost estimates were also obtained and are given for the removal of sulfur oxides from reverberatory furnace off-gas at a copper smelter. Six major process and engineering problem areas still requiring demonstrated solutions are identified and discussed.

39634

POLLUTION CONTROL AT A COPPER SMELTER. NORDDEUTSCHE AFFINERIE BUILDING THE LARGEST SMELTER ACID PLANT IN EUROPE. Sulphur, no. 95:45-46, Aug. 1971.

Apart from the oxide ores, which are less important as sources of copper, the output from most copper mining operations is in the form of the sulfide minerals: chalcopyrite, chalcocite, and bornite. Most concentrates supplied to the copper smelters also contain some pyrite. The conventional pyrometallurgical process for producing copper involves two stages. First, the concentrates are smelted in a reverberatory furnace to copper matte, which is a mixture of iron (II) sulfide and copper (I) sulfide. In the second stage of the process, copper matte from the reverberatory is treated in a converter for the production of blister copper, which may be refined further, either by heat treatment or by electrolytic reduction. A German firm roasts the concentrates to remove some of the sulfur content prior to the reverberatory smelting stage. Now under construction, the new facilities of the firm will incorporate a flash-smelting furnace, in which the roasting and smelting processes are effectively combined into one operation. Another advantage of the flash-smelting furnace is that its closed design enables all the furnace gas to be channelled to the sulfuric acid plant. The sulfuric acid plant operates on the Bayer double-catalysis process.

40006

Dayton, Stan

WET SCRUBBING OF WEAK SO2 GETS A TRIAL AT NEW MCGILL PILOT PLANT. Eng. Mining J., 172(12):66-68, Dec. 1971.

Wet scrubbing of smelter gases is used as a control method in a new pilot plant at the McGill reduction plant of Kennecott Copper Corp. s Nevada Mines Division near Ely, Nevada. Preliminary results were revealed by the Smelter Control Research Association. Test results are analyzed by computer. Limestone scrubbing require about 8 lbs limestone per pound sulfur treated, raising a problem for custom smelters or those located far from the concentrator because of lack of a tailing pond. At such locations, wet scrubbing systems can be viewed as trading an air pollution problem for a solid waste problem.

40073

Harkins, W. D. and R. E. Swain

PAPERS ON SMELTER SMOKE. (FIRST PAPER). THE DETERMINATION OF ARSENIC AND OTHER SOLID CONSTITUENTS OF SMELTER SMOKE, WITH A STUDY OF THE EFFECTS OF HIGH STACKS AND LARGE CONDENSING FLUES. J. Am. Chem. Soc., 29(7):970-998, July 1907. 15 refs.

The amount of arsenic expelled from the greatest of the world s smelters--a plant which has a capacity of ten thousand tons of ore per day, and the output of which for 1906 was estimated as eleven and one half per cent of the world s production of copper--was estimated. The smoke and the grasses of the district were found to contain considerable arsenic, while small quantities of this element were found in the organs of herbivorous animals living in the vicinity of the smelter. As a result of the operation of the new smelter, the losses of stock in the valley during the year 1902 were so heavy, and the hay and grass, on analysis, showed so much arsenic, that a great system of flues was built in order to settle the copper and to condense the arsenci trioxide. Velocity determinations, measurement of temperature, velocity measurements for smoke samples, and the collection and determination of the total weight of the solids were undertaken to ascertain the efficiency of the flues and stack. General effects of the high stack are indicated, and measurement methods are discussed in detail.

40760

Bureau of Mines, Washington, D. C.

CONTROL OF SULFUR OXIDE EMISSIONS IN COPPER, LEAD AND ZINC SMELTING. Bureau of Mines Information Circ., no. 8527:1-62, 1971 6 refs.

Removal of sulfur oxides from copper, lead, and zinc smelter gases will require substantial capital investment. The copper smelting industry anticipates expenditures of $600 million in order to conform to a 10% standard. The lead and zinc industry is expected to spend at least $100 million. According to industry specialists the smelting cost of copper may rise 4 cents/lb from current levels of 4 to 6 cents/lb. Lead is expected to increase 2 to 4 cents over the current cost of 2 cents/lb. Zinc may increase 1.5 cents/ lb from its current price of 6 cents/lb. Companies may find it difficult to pass the cost on to the ultimate consumer. Controversy has arisen between the metals industry and governmental control agencies over the status of stack gas desulfurization processes. New markets for sulfuric acid produced during effluent gas scrubbing must

be discovered. Air pollution regulations and emission standards are mentioned. Sulfur dioxide control methods include tall stacks, conversion to H2SO4 by the contact method, absorption, lime and limestone scrubbing to yield sulfur compounds, and reduction of SO2 to elemental sulfur.

41540

Haver, F. P. and M. M. Wong

MAKING COPPER WITHOUT POLLUTION. Mining Engineering, 24(6):52-53, June 1972.

A proposed method for the treatment of copper concentrate appears to be well suited to a continuous operation on a large scale in locations having regulations controlling air and water pollution. Mixtures of copper concentrate and lime were brought to the ignition point, 400 C, and the reaction was allowed to proceed with no external heating. An amount of lime equivalent to the sulfur present in the concentrate is necessary to avoid air pollution. After 3 hr roasting, the mixture was leached with 20% hydrochloric acid. Under optimum conditions, the leach solution contained 99% of the copper, 96% of the molybdenum, and 87% of the iron present in the concentrate. Molybdenum was removed from the solution with activated carbon, and the copper was reduced with sponge iron. Hydrochloric acid was regenerated for further use, and iron oxide was a byproduct. The residue from roasting was 82% anhydrite from which gold was removed bycyanidization. The chief expenses in an industrial scale installation would be for lime, sponge iron, and HCl regeneration. The concentrate used in the test yielded cement copper, molybdenum trioxide, gold, silver, and ferric oxide plus an amount of calcium sulfate equivalent in weight to the concentrate treated.

42216

Momoda, Ryokichi, Nobuo Tsutsumi, and Shinichi Higuchi

ON THE DIRECT SMELTING OF COPPER CONCENTRATES BY BLAST FURNACES ACCOMPANIED WITH SULPHURIC ACID PRODUCTION. Preprint, American Inst. of Mining, Metallurgical, and Petroleum Engineers (AIME), New York, N. Y., 15p., 1971. 2 refs. (Presented at the American Inst. of Mining, Metallurgical, and Petroleum Engineers Annual Meeting, New York, Feb. 26-March 4, 1971.)

A direct smelting process makes it possible to charge copper concentrates directly into a blast furnace without complicated preliminary treatment. The process simplifies smelting operation, and the exhaust gases are used for the production of sulfuric acid. Advantages of the process over conventional blast furnace operation are the following: complex preliminary treatment of copper concentrates is not required; sulfuric acid is produced at high yield; slag fall, flue dust, and Cu grade of slug are low, so that the yield of Cu can be heightened; the combustion heat of both sulfur and iron contained in the concentrates can be utilized effectively within the furnace to result in saving fuel consumption; as the operational systems are simplified, both manpower and electric power can be saved; and sulfur dioxide pollution is avoided. The process has certain restrictions as to the ratio of lumps and fines to charge into the blast furnaces, and also special sandy concentrates. The process has been adapted for an oil injection method.

42282

SEARCHING FOR SOLUTIONS TO POLLUTION PROBLEMS. Eng. Mining J., 173(6):178-183, June 1972.

Hydrometallurgical processes have often been suggested as an attractive alternative to the pollution prone smelting techniques. Chalcocite has been treated by acid pressure leaching to yield elemental sulfur and a copper sulfate solution from which the copper may be recovered electrolytically. Nitric acid also has been suggested for reaction with copper sulfides to yield sulfur, and the old technique of using ferric chloride solution to leach copper sulfides is being re-examined. Early in 1971 the eight major copper companies which account for all the U. S. primary copper smelter production announced the formation of a new research association; its objective is the development of improved methods for removing sulfur oxides and particulates from smelter off-gases. Over 100 processes or variations were reviewed by the new organizations, the Smelter Control Research Association, before selecting wet limestone scrubbing as a candidate for pilot plant study. The cost to the copper industry of pollution control is cited. The deSeversky Hydro Precipitol process, which involves ammonia injection and a granular bed device, can be used to remove both sulfur dioxide and fly ash simultaneously. The reduction of SO2 to elemental sulfur, reverberatory smelting modifications, continuous smelting and converting processes, the Monsanto Cat-Ox process, the Wellman-Power Gas SO2 recovery process, acid mine water treatment, ion exchange removal of mercury, and the combination of pollution control with production of some salable by-product are discussed.

43298

Agarwal, J. C. and J. R. Sinek

APPLICATION OF PROCESS ENGINEERING TO ENVIRONMENTAL CONTROL IN METALLURGICAL PLANTS. Preprint, American Inst. of Mining, Metallurgical and Petroleum Engineers (AIME), New York, N. Y., 13p., 1971. (Presented at the American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting, 100th, New York, Feb. 26-March 4, 1971.)

The objectives of process engineering are: to analyze the options that are technically feasible for the solution of a given pollution problem; to rank these options in the order of preference, according to economic criteria; and to present those options to management, with the cost information peculiar to each option. The approaches to environmental control are twofold, to take the process as is and clean the effluents, or to design the system to eliminate pollutants. The most profitable method is to institite changes at the plant design stage. Case histories of process engineering improvements are presented as examples to stimulate creative approaches. Particulate loading in blast furnace top gas has been controlled by pelletizing the ore charge and installing venturi scrubbing. This allowed temperature increases to nearly 2000 F, cut coke fueling in half, and cleaned top gas to less than 0.02 gr/scf. Five methods and their relative merits are discussed for top gas cleaning. The elimination of acid plumes has been accomplished by the Japanese copper smelting industry by rigidly air admission and gas temperature. Environmental control can only be dealt with by forming a cadre of process engineers versed in process and cost engineering.

43877

Worner, Howard K.

WORCRA METALLURGY LOOKS PROMISING FOR POLLUTION CONTROL IN COPPER PLANTS. Eng. Mining J., 172(8):64-68, Aug. 1971. 4 refs.

WORCRA pyrometallurgy is summarized as it applies to copper production. The differences between the WORCRA approach and the traditional methods of reverberatory converter and blast furnace converter are depicted. Continuous smelting, converting, and slag cleaning by conditioning and settling are

combined in a single furnace by the WORCRA process. WORCRA smelting.converting produces metal, rather than matte, directly from concentrates. Most of the exothermic oxidation reactions are generated and continued within the liquid bath, hence the description bath smelting. The bath in the smelting and converting zones is turbulent and continuously flowing. Turbulence is due to the injection of oxygen-containing gas from lances. In the converting zone, slag moves under gravity, generally counter-current to matte and metal. Copper-in-slag is reduced to throw-away levels as the slag flows through the smelting zone and slag cleaning zone; there is no revert slag, nor the necessity for separate copper recovery treatments. The sulfur dioxide bearing gases generated in the smelting and converting stages combine and leave the single furnace continuously at a rich tenor via one gas offtake. Rich in SO2, the furnace gases can be treated for waste heat utilization and dust recovery in conventional gas cooling and dust collection equipment, prior to venting through a stack or treatment in a sulfuric acid plant. Since the gases are low in oxygen content, their processing for elemental sulfur recovery could also be attractive. Possible furnace shapes, pilot-plant trials, a semicommercial installation, and WORCRA s role in pollution control are discussed.

44134

Themelis, N. J., G. C. McKerrow, P. Tarassoff, and G. D. Hallett

THE NORANDA PROCESS. J. Metals, 24(4):25-32, April 1972. 7 refs. (Presented at the American Institute of Mining, Metallurgical and Petroleum Engineers, The Metallurgical Society, Annual Meeting, 100th, Feb. 26-March 4, 1971.)

The Noranda Process offers an alternative to conventional reverberatory and converter smelting of copper concentrates. It reduces fuel consumption by making full use of the exothermic heat of the converting reactions in a single furnace. The size of the smelter building and of such auxiliary equipment as waste heat boilers, flues, and Cottrells are reduced. Unlike conventional smelting, the copper content in the slag is not geared to the concentrate grade. Slag of variable composition can be successfully treated by milling, to produce a high grade copper concentrate which is recycled, and a low copper tailing which is discarded. Of particular importance is the fact that the process generates a continuous flow of high strength sulfur dioxide gas which is suitable for the manufacture of sulfuric acid. The technical feasibility of the Noranda process was established in a large scale pilot plant. The process is described, including operation of the pilot plant, development work, results, and scale-up to an industrial plant. (Author conclusions modified)

44367

Ichijo, Michio

ZINC, COPPER, AND CADMIUM REFINERIES. (Aen, do, kadomiumu seirenjo). Text in Japanese. Kinzoku Zairyo (Metals in Engineering), 12(5):20-26, May 1972. 14 refs.

A general discussion is given of the present status of pollution control in various metal refineries. In 1969, only 30.7% of the total sulfur dioxide from zinc, copper, and cadmium refineries in the U. S. was recovered, the other 69.3% being released to the atmosphere. A control policy has since been formulated. Sulfur dioxide in flue gas is usually recovered as sodium sulfite, ammonium sulfate, sulfuric acid, gypsum, or high concentrated SO2. There is a wide range of dust-generating sources. The problem is being gradually solved through use of cyclones, bag filters, electrostatic precipitators, scrubbers, and other control equipment. The treatment of waste water and sludges, and the removal of mercury and arsenic, are also described. Processes for the removal of mercury from flue gas and the wet treatment of pyrites are illustrated in flow charts.

45131

Thompson, R. and E. B. Butler

HISTORY OF SULFURIC ACID PRODUCTION FROM CONVERTER GAS AT THE KENNECOTT COPPER CORPORATION S UTAH SMELTER. J. Metals, 20(7):32-34, July 1968.

A review of 57 years of experience of sulfuric acid manufacture acquired by Kennecott Copper Corp. of Magna, Utah, is presented, and the improvements brought to its six acid plants are described, including the air pollution control devices installed. In 1936 the company constructed the first contact plant, designed to produce 100 ton/day of sulfuric acid on a 100% basis from 7% sulfur dioxide roaster gas. The desirability of using the sulfur in the copper concentrate resulted in construction of a small gas-cleaning plant. The plant consisted of two multicyclones, and air-to-gas cooler, and a hot plate-and-wire electrostatic precipitator ahead of scrubbing towers and mist precipitators. Gas flow was obtained with a hot gas fan and two intermediate fans in parallel. A third sulfuric acid plant was constructed in 1950, followed by a gas-cleaning plant in 1951. A new hot electrostatic precipitator capable of treating the total volume of smelter converter gas, was connected to the converter flue by a 600-feet long balloon flue. With its 22-foot diameter, this flue served as a settling chamber for dust, and provided a large surface for heat radiation. Multicyclones and gas coolers were no longer needed. A fourth acid plant was constructed in 1953, followed by a fifth acid plant in 1956, designed for 250 ton/day. For each new plant, the gas cleaning facility was enlarged by adding an intermediate fan, scrubbers, and mist precipitators. The sixth plant, for production of copper, was completed in 1967. Theoretical strengths of sulfur dioxide evolved are 14% during the slag blow, and 21% in the end stage, but this is diluted by air leakage into the hoods, the flue system, and the gas-cleaning process, so that gas from a single copper converter can vary from zero to 8% sulfur dioxide. The seventh acid plant under consideration, with a capacity of 500 ton/day, would enable the smelter to use virtually all of the converter gases for the manufacture of sulfuric acid. The production of sulfuric acid is desirable, because it minimizes stack emissions.

45183

Rodolff, Dale W. and Earl R. Marble, Jr.

INSPIRATION S NEW LOOK. J. Metals, 29(7):14-24, July 1972.

As part of its plans to comply with new state emission standards, an Arizona copper smelter is replacing its gas-fired reverberatory furnace with an electric furnace and Peirce-Smith converters with siphon converters. These changes will ensure that the optimum gas volume and concentration of sulfur dioxide are delivered to the sulfuric acid plant that is also planned for the smelter. Charge for the 35-foot-wide by 117-foot-long electric furnace will first be dried in a rotary dryer to reduce its moisture content to 0.3%, then transported to the furnace through totally enclosed drag conveyors. Because an electric furnace eliminates dilution of gases by the large volume of combustion products resulting from burning of fuel in a reverberatory furnace, the SO2 content of the exit gases will average 4.0-8.0% vs the present 0.5-1.5%. Furnace and converter gases will be cooled to 850 F and 900 F, respectively, in radiation-convection coolers and passed through electrostatic precipitators for particulate recovery. Subsequently, the furnace and converter gases will be combined and further

cooled and purified in venturi scrubbers, packed towers with countercurrent flow, and electrostatic mist precipitators. A double absorption contact plant, with four vanadium pentoxide catalyst beds, will provide the desired degree of SO2 recovery from the cleaned gas. The plant will have the capacity for producing 93% or 98% acid.

46560

Petrushov, V. P., G. M. Gordon, and D. F. Aptekar

MEASURES APPLIED TO REDUCE THE AGGRESSIVITY OF WASTE GASES AND TO IMPROVE THE WORKING CONDITIONS FOK BAG FILTER TISSUES. (O merakh po snizheniyu agressivnosti gazov i uluchsheniyu usloviy raboty tkani rukavnykh fil trov). Text in Russian. Tsvetn. Metal., no. 7:29-31, July 1972.

Measures applied to reduce the aggressivity of the waste gases and to improve the working conditions for the bag filters at a copper melting plant processing dusts with high sulfur content and ashes from thermal power plants are described. The waste gases to be treated contained up to 3.5% of sulfur dioxide and up to 0.2% of sulfur trioxide. To reduce the aggressivity of the waste gases, powdered lime was added into the charge at a rate of 3-4%, or to the waste gas in an emergency as soon as the SO2 content exceeded 0.4 g/N cu m. Sulfur trioxide is neutralized by means of partly oxidized residues from the separating chamber and cyclones before the bag filter, which are added to the dust charge at a rate of 10%. The replacement of mazout by diesel fuel resulted in a decrease in the SO2 content to 0.08- 0.15 g/N cu m. Flannelette filters were replaced by Nitron fiber filters to reach operating temperatures of 135-140 C and a filter resistance of 8-120 mm water column. Dedusting is done by periodic knocking with air counterflow at 80-100 C temperature. As a result of the above measures, the bag filter efficiency was above 99%, and the waste gases entering the bag filter contained 0.28-0.7 g of SO2 and 0.0056-0.0112 g of SO3/cu m. The raw gas composition was automatically controlled by variation of the charge temperature, was neutralized with powdered lime, and had increased air intake. It was thus possible to increase the life of the tissue filter to 11.5-12 months.

46931

Milliken, C. L.

COPPER MELTING PLANTS OF THE SEVENTIES. (Kupferschmelzanlagen der Siebziger Jahre). Text in German. Metall (Berlin), 26(11): 1105-1107, 1972. 5 refs.

The conventional copper melting plants are in difficulty because of the increasingly stringent regulations concerning environmental pollution. The greatest problem these plants face is the reduction of the emission of sulfur dioxide. The number of experimental plants for the recovery of the SO2 in form of elemental sulfur from the waste gases is large. In some instances waste gas cleaning plants were attached to the copper melting plants, in some cases the melting process itself was modified. An example for the first method is the Onahama plant of the Mitsubishi Metal Mining Company. This plant uses stainless steel flues leading from the converter to a waste heat boiler for reducing the gas temperature. An electrostatic precipitator is followed by a Lurgi double catalyst sulfuric acid plant. The Outokumpu Oy plant in Finland uses flash melting with waste gases containing about 14 to 15% SO2. Through the higher SO2 concentration these gases can be more economically treated for sulfur recovery. The best melting process would combine the Outokumpu flash furnace with a stationary top-blasted converter. A flue, tightly connected to the converter, would lead to a heat exchanger and to the gas cleaning plant. The flue could be water cooled and designed so that it becomes part of the heat exchanger.

48423

Weisburd, Melvin I.

PRIMARY AND SECONDARY NON-FERROUS SMELTING AND REFINING. In: Field Operations and Enforcement Manual for Air Pollution Control. Volume III: Inspection Procedures for Specific Industries. Pacific Environmental Services, Inc., Santa Monica, Calif., Office of Air Programs Contract CPA 70-122, Rept. APTD-1102, p. 7.8.1-7.8.50, Aug. 1972. 6 refs.

The smelting and refining of non-ferrous metals are primarily concerned with the production of copper, lead, zinc, and aluminum ingots and alloys. Primary smelters usually constitute large, difficult to control single sources of air pollution, are usually located outside of urban areas, and can be significant sources of visible emissions and plant damage. Secondary smelters are commonly found in industrial and urban areas, close to sources of scrap and other raw materials generated by population centers. They are significant sources of pollution, as well as local public nuisance problems. Sources of emissions, processes, and inspection points are discussed for primary and secondary non-ferrous smelting and refining. Roasting, reverberatory furnaces, converters, and contaminants emitted are included for copper production. Sintering, blast furnaces, refining, and contaminants emitted are included for lead production. Roasting, sintering, extraction, and contaminants emitted are included for zinc production. Operations and equipment for reclaiming metals from scrap, drosses, and slag are considered, for brass and bronze, lead, zinc, and aluminum. Smoke, dust, fumes, sulfur oxides, fluxing, and degreasing agents are typically emitted.

C. MEASUREMENT METHODS

01098

E. H. Dudgeon and E. V. Evans

THE RAPID, CONTINUOUS MEASUREMENT OF SULPHUR DIOXIDE IN THE FLUE GAS FROM A COPPER CONVERTER. National Research Council of Canada Ottawa (Ontario), Div. of Mechanical Engineering Nov. 1965. 54 pp. (Mechanical Engineering Rept. MT-55 DDC: AD 479 876

The sulphur dioxide concentration of the gas emitted from a copper converter has been measured on a continuous time basis with an over-all time lag of less than 10 seconds. An infrared analyser was used as the detection unit. The sulphur dioxide level was used to predict the end point of the copper blow phase of the conversion operation, independently of any sampling of the melt or other observations. (Author summary)

03203

E. H. Dudgeon.

THE MEASUREMENT OF THE SULPHUR DIOXIDE CONTENT OF COPPER CONVERTER GASES AS AN AID TO CONVERTER CONTROL. Can. Mining Met. Bull. Montreal 59, (655) 1321-8, Nov. 1966.

The SO2 level in the flue gas released from a copper converter was measured by infrared analysis with a Beckman Instrument Model IR315. The experiment was designed to determine whether this method could be used to determine the end point in the converter operation automatically instead of manually. Variations in the SO2 level of the flue gas during normal converter operation were recorded. It was conlcuded that the method is practical, however, some modifications will have to be made before it will be completely accurate.

28492

Fineman, I., K. Ljunggren, H. G. Forsberg, and L.-G. Erwall

ACTIVATION ANALYSIS FOR SELENIUM IN ORE CONCENTRATES, SLAGS AND WASTE GASES OBTAINED IN A METALLURGICAL INDUSTRY. Intern. J. Appl. Radiation Isotopes, vol. 5:280-288, 1959. 17 refs.

Various methods for the activation analysis of selenium in ores, slags, and metallurgical waste gases were investigated. When the ratio of selenium gamma-activity to gamma-activity of higher energy was higher than about 0.01, spectrometric activation analysis was possible. A chemical activation analysis of materials containing 0.001-0.1% selenium is easily performed if the materials are soluble. Both Se(75) and Se(81m) can be used for the spectrometric method but only Se(75) for the chemical method. Selenium data obtained by both methods are given for three materials from different stages of copper production: slag, an arsenic concentrate, and a copper concentrate. Only the chemical method gave accurate values for all materials. The use of a special spectrometric activation analysis method using the gamma-cascades of selenium was also investigated. Spectrometric activation analysis was additionally applied to the analysis of selenium in waste gas from one stage of copper production. Only an upper limit (50 micrograms Se/l for the selenium content could be established.

D. AIR QUALITY MEASUREMENTS

05145

J. L. Sullivan

THE NATURE AND EXTENT OF POLLUTION BY METALLURGICAL INDUSTRIES IN PORT KEMBLA (PART I OF AIR POLLUTION BY METALLURGICAL INDUSTRIES). Australia Dept. of Public Health, Sydney, Division of Occupational Health. 1962. 62 pp.

Air pollution was surveyed in a metallurgical town, Port Kemble, located on the coast of Australia. Iron and copper ores are smelted and the major emissions consist of solid particulates and sulphur dioxide gas. The presence of the latter is most noticeable in the wake of the plume of the stack of the copper smelter during the north-east winds which prevail in summer. In winter the prevailing winds cause industrial pollution to be blown seawards. Tests for sulphur dioxide were made by daily volumetric sampling instruments and a Thomas automatic recorder. The section of the town most severely affected consisted of a swathe of about 200 yards wide and extending to a point where habitation ceased about 0.6 mile from the 200 feet high stack of the copper smelter. Daily readings of the gas were not spectacular and the highest result was 0.62 part per million. During a little more than three years 24 hour readings of 0.2 part per million or more were measured on 39 days. However, a different picture was obtained from the continuous recorder. This showed that high concentrations of sulphur dioxide tended to occur in episodes of a few hours each. Peaks of greater concentration than 5 parts per million were recorded on numerous occasions and the maximum for the sampling period was 13.5 parts per million at a point 0.45 mile from the source. Complaints of respiratory distress were made frequently and most householders had ceased to try to grow vegetables. Dust-fall rates measured as water insoluble solids by a deposit gauge consisting of a six inch diameter conical glass funnel and bottle were high by normal standards. Average annual rates varied between 17.9 and 86.1 tons per square mile per month. In some locations within a half mile from the edge of the steel industries summer dust-fall rates were found to exceed 100 tons per square mile per month. At one point a mile and a half from the steel industries the monthly rate during 1960 varied between 13.6 and 43.4 tons per square mile. Smoke densities were found to be low by comparison with other cities in New South Wales despite frequent evidence of haze. The introduction of oxygen lancing on open-hearth furnaces, without control measures, had little or no effect on smoke density levels. (Author abstract modified)

10517

Robinson, E. and R. C. Robbins

SOURCES, ABUNDANCE, AND FATE OF GASEOUS ATMOSPHERIC POLLUTANTS (FINAL REPORT.)Stanford Research Inst., Menlo Park, Calif., SRI-P 6755, 123p., Feb. 1968. 120 refs.

An analysis of the sources, abundance, and fate of gaseous atmospheric pollutants is presented, considering three families of compounds: sulfurous, nitrogenous, and organic; and two inorganic carbon compounds: carbon monoxide and carbon dioxide. With the exception of CO2, similar patterns of analyses of these materials a followed and rather detailed analyses are produced. The presentati of CO2 is only a brief review of the current state of thinking. Included are estimates of annual world-wide emissions of pollutants SO2, H2S, CO, NO2, NH3, and organics. The magnitudes of the natura emanations of a variety of materials have also been considered, although the means of estimating these emissions are very crude because so little study has been made of emissions from other than urban air pollution sources. Sulfur compounds, in the form of SO2, are currently the most topical of the numerous air pollutants. Sulfur enters the atmosphere as air pollutants in the form of SO2, H2S, H2SO4, and particulate sulfates; and as natural emanations in the form of H2S and sulfates. Among the various sources of CO, automobile exhaust accounts for more than 805 of the estimated worl wide CO emission. The major sources for the gaseous nitrogen compounds are biological action and organic decomposition in the so and perhaps in the ocean. Aerosols containing NH4 ions and NO3 ion are formed by atmospheric reactions involving the various gases. Major contributions of hydrocarbons include natural CH4 emissions from flooded paddy areas, terpene-class organics evolved by vegetation, and pollutant emissions. A brief review of present understanding of CO2 in the atmosphere indicates a clear example of situation where pollutant emissions are significant enough to cause measurable changes in the ambient concentrations.

E. ATMOSPHERIC INTERACTION

12777

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME III: APPENDICES C THROUGH G. Contract PH 86-65-85, Rept. 993, 114p., June 1969. 130 refs. CFSTI: PB 184 886

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. Various sulfur oxides control methods, including scrubbing, absorption, and reduction, are matched with smelter models to determine optimum control and production combinations. A precise analysis of the pollution potential of an individual smelter requires meteorological data for the specific smelter site. The variables that can be considered in such a topographical analysis include inversion frequencies, monthly mean maximum mixing depths, surface winds, and general airflow conditions. An analysis of the U. S. markets for zinc, lead, and copper is presented, as well as markets for sulfur byproducts. A literature review of control methods for sulfur oxide emissions from primary copper, lead, and zinc smelters is included.

32255

Heck, Werner J.

RELATIONSHIP OF WIND VELOCITY AND STABILITY TO SO2 CONCENTRATIONS AT SALT LAKE CITY, UTAH. National Oceanic and Atmospheric Administration, Salt Lake City, Utah, Scientific Services Div., NOAA NWSTM WR-61, 21p., Jan. 1971. 2 refs. NTIS: COM-71-00232

Air pollution, with special attention to sulfur dioxide, is discussed for Salt Lake City, Utah. Continuous sources of SO2 emission were a copper smelter, located 15 miles west of the city, oil refineries, five miles to the north, steel refineries, 30 miles to the south, and motor vehicles within the metropolitan area. Intermittent sources included the burning of tires, oil, and scrap automobiles in dumps around the city. The relationship between wind velocities and SO2 concentrations during late fall and winter and a high pollution episode for the relationship between day-to-day SO2 concentrations and mixing depth were studied. Sulfur dioxide concentrations increased rapidly in downtown Salt Lake City during morning hours with the transition from south-southeast drainage winds to north-northwest up-valley winds. Pollutants were sufficiently diffused throughout the afternoon so as not to produce another SO2 maximum with the transition back to the drainage wind in the early evening. A north-northwest wind was not, however, necessary for a rapid increase of hourly SO2 concentrations. Sulfur dioxide concentrations increased significantly under a stagnant high-pressure system with rapidly decreasing mixing depths. Winds were an important factor in the increase of hourly SO2 concentrations, while the mixing depth affected the increase of average daily SO2 concentrations.

46342

Reynolds, George W.

THE CLOUD SEEDING POTENTIAL OF SALT LAKE VALLEY AIR POLLUTION - COLD SEASON. Preprint, Colorado State Univ., Fort Collins, p. 39-40, 1970. (Presented at the National Conference on Cloud Physics, Fort Collins, Colo., Aug. 24-27, 1970.)

Horizontal and/or vertical samplings of the number of ice nuclei were conducted during 21 flights on 11 days during Feb. and March 1970 in a pilot study over Salt Lake Valley, Utah. The area is within 20 mi of the 4000 to 5000-foot-high face of the Wasatch Range, with possible wind and precipitation implications. Ice nuclei were estimated by visual counting using a modified MRI cold box. All counts were at 20 C. The highest count was 6000/l and counts of at least 1000/l were noted at one or more levels on 70% of the flights. There was no clear evidence that time of day exerts a consistent control of the number of ice nuclei during daylight hours. The Garfield copper smelter was a primary source of ice nuclei; steel mills also appeared to be a source under some circumstances. Further evidence is needed on the contributions of large refineries and/or heavy traffic near Salt Lake City. The high concentrations tended to occur in layers 1000-4000 ft thick; the bases of these layers were generally more than 1000 ft above the valley floor.

F. BASIC SCIENCE AND TECHNOLOGY

10032

Reuss, J. L. and M. M. Fine

NONPYRITIC SMELTING OF COPPER CONCENTRATES. Dept. of Interior, Washington, D.C., Bureau of Mines, RI-7119, 10p., April 1968. 12 refs

The technical feasibility of smelting copper concentrates containing chalcocite (Cu2S) and native copper using nonpyritic sulfur-bearing materials to aid matte formation was investigated. The procedure consisted of combining various proportions of commercial chalcocite concentrate, smelter slag, fluxes, and matte forming constituents to produce charges of comparable compositions. The mixtures were charged in fireclay crucibles and smelted in an induction furnace at 1,300 deg.C. The research proved that either sulfur or gypsum can replace pyrite as a matte-forming material, an that gypsum produces and exceptionally high-grade copper matte. Th addition of small quantities of metallic iron to the nonpyritic smelting charge furthers the removal of sulfur, improves the recove of copper, and makes it possible to utilize gypsum as the exclusive flux and matte-forming ingredient, thereby eliminating the necessit of adding limestone. Factors influencing the loss of sulfur, as SO to the atmosphere are discussed. (Authors' abstract, modified)

13534

Mackiw, V. N.

CURRENT TRENDS IN CHEMICAL METALLURGY. Can. J. Chem. Eng., 46(1): 3-15, Feb. 1968. 52 refs.

Recent developments in hydrometallurgy and pyrometallurgy are reviewed. Some processes presently in commercial operation and some in the developmental stage are presented from the standpoint of extraction of metals and from their fabrication into useful materials. The chemical reactions of various commerical processes are shown both graphically and chemically. New processes are presented for the treatment of Zn Cu, and Pb concentrates, complex Pb-Zn, Cu, FeS2 bulk concentrates, and Zn plant residues. A combination of roasting and hydrometallurgy for the recovery of molybdenum from molybdenite is displayed diagramatically. Laterite treatment and other investigations and reactions are reviewed. It is concluded that new products from new processes will evolve economically through a new technology.

13936

Davtyan, O. K. and Ye. N. Ovchinnikova

CHEMISORPTION AND OXIDATION OF SULFUR DIOXIDE ON SOLID CATALYSTS AT NORMAL TEMPERATURE. (O khemisorbtsii i okislenii sernistogo angidrida na tverdykh katalizatorakh pri normal'noy temperature). Text in Russian. Doklady Akad: Nauk SSSR, 104(6):857-860, 1955.

An attempt was made to explain the catalytic oxidation of sulfur dioxide on the basis of a theory proposed by O. K. Davtyan. The following catalysts were studied: spongy platinum applied to porous phosphorus through reduction from a solution of chloroplatinic acid, activated charcoal, vanadium pentoxide obtained by coagulation of a colloidal solution in the form of a powder (without carrier), powdered graphite, powdered chromium trioxide, and powdered ferric oxide (listed in order of decreasing activity). In all cases, chemisorption was found to proceed with sufficiently high rate at room temperature, the oxidation products being readily removed as sulfuric acid by washing with water. Curves of total adsorption and chemisorption rates as a function of time were plotted. It is noted that the presence of water vapor on the catalyst surface usually increases the maximum quantity of oxidized sulfur dioxide.

14572

Tikhonov, A. I. and I. T. Sryvalin

THERMODYNAMICS OF THE BASIC REACTIONS OF CHLORINATION ROASTING. (Termodinamika osnovnykh reaktsiy khloriruyushchego obzhiga). Text in Russian. Tr. Ural'sk. Politekhn. Inst., no. 98:33-40, 1960. 11 refs.

Results from thermodynamic calculations of the most important reactions of chlorination roasting over the range 573-973 C are presented. These reactions may be represented for the metals Na, Fe, Co, Ni, and Cu by the generalized formulas: Me plus Cl2 yields MeCl2; 2MeS plus 2Cl2 yields 2MeCl2 plus S2; 2MeO plus 2Cl2 yields 2MeCl2 plus O2 and its reverse; MeO plus C plus Cl2 yields MeCl2 plus CO: MeO plus CO plus Cl2 yields MeCl2 plus CO2; MeS plus 2O2 yields MeSO4; and MeSO4 plus 2NaCl yields Na2SO4 plus MeCl2. The values for standard isobaric potential and equilibrium constants tabulated were derived from data taken from both U. S. and USSR sources and may be used to study the mechanism of the process and to select process conditions.

14745

Ingraham, T. R.

THERMODYNAMICS OF THE THERMAL DECOMPOSITION OF CUPRIC SULFATE AND CUPRIC OXYSULFATE. Trans. AIME (Am. Inst. Mining, Metallurgical, and Petroleum Engr.), 233(2):359-363, Feb. 1965. 20 refs.

The thermal decomposition of cupric sulfate and cupric oxysulfate was examined by determining the equilibrium gas pressure generated over each pure compound. The equilibrium data were used to calculate the thermodynamic properties of both compounds. The results were combined with previously published data to establish a predominance-volume diagram for the Cu-S-O system over a normal range of roasting temperatures and gas compositions used in the treatment of copper minerals. It was found that copper oxysulfate recrystallizes at 1100 K with an apparently irreversible endothermic heat requirement of approximately 2.9 kcal per mole. (Author abstract modified)

15430

Gadalla, A. M. M. and J. White

EQUILIBRIUM RELATIONSHIPS IN THE SYSTEM CuO-Cu2O-MgO. Trans. Brit. Ceram. Soc., 63(3):119-134, 1940. 7 refs.

Following similar studies on the systems CuO-Cu2O-SiO2 and CuO-Cu2OhAl2O3, phase equilibrium relationships in the system CuO-Cu2O-MgO were investigated as a function of temperature and oxygen pressure (0.21 to 1.0 atm) using a thermobalance. From the observed relationships, the existence of an extensive range of MgO-rich solid solutions which can contain both Cu(2+) and Cu(+) ions was established. An intermediate compound was shown to exist at a composition approximating 2CuO.MgO. No evidence was found or reported of the existence of the compound CuO.MgO. Two invariant points on the liquidus surface of the ternary diagram were located in terms of oxygen pressure, temperature and composition, and a diagram showing the sub-solidus relationships in the ternary system CuO-Cu2O-MgO was constructed. From the oxygen pressure/temperature relationships established for the monovariant transitions occurring in the solid state, expressions were derived, within the limits of accuracy of the experimental data, for the standard free energies of the corresponding reactions. Recent work indicates that this system may be of particular interest in the refractories field, since it has been found that attack by copper oxides is an important factor in the failure of magnesite refractories in copper anode melting-furnaces and copper converters. (Author abstract modified)

20043

Oya, Shigeo and Hideya Shimizu

GAS ABSORPTION IN COPPER AND COPPER-BASE ALLOYS IN THE LIQUID STATE. (Do oyobi do-gokin yoto no gasu kyushu). Text in Japanes Imono (Foundry), 38(1):33-49, Jan. 1966. 103 refs.

The absorption of gas from molten copper and copper-base alloys is performed by air within the hearth. This air includes O2, N2, H2, H2O, CO, CO2, SO2, and hydrocarbons, and the amount of each component varies with the type of hearth or its driving technique. The absorption of H2 by the melting copper rapidly increases above 1,100 C with an increase in temperature and by the adding of small amounts of nickel (Cu 100 grams vs. Ni 20 to 30 grams) and decreases slightly by adding Sn or Al. The large molecular compounds such as H2O, SO2, CO, and CO2 may not exist easily within the melting copper or its alloys, and can cause bubbling of these gases when the partial pressure of the gas reaches the atmospheric pressure. The H2O and SO2 gas are produced within the purified copper or CU-Sn alloy, H2O, CO, and SO2 gas within the Cu-Ni alloy. The absorption of SO2 slowly increases with an increase in the temperature and internal pressure of the hearth. The H2 and H2O gases in the hearth air play the most important role in the quality of copper or copper- base alloys. This aspect should further be advanced.

43792

Ichida, Norimitsu

THE DESIGN CONSTRUCTION OF THE REVERBERATORY FURNACE WITH EFFECTIVE FACILITIES AT NAOSHIMA NEW COPPER SMELTER AND REFINERY. (Konoritsu setsubi o kanbi shita hansharo-ho ni yoru Naoshima shin-seirenjo no sekkei narabi ni kensetsu). Text in Japanese. Nippon Kogyo Kaishi (J. Mining Met. Inst. Japan), 87(1001):509- 514, July 1971.

The new copper metallurgical complex of the Mitsubishi Metal Mining Company was designed for a monthly production of 7000 tons of electrolytic copper, which was achieved in March 1970. Smelting and refining processes, tonnages, and assays of products are described. Particular emphasis is given to the partial roasting fluidized bed process for copper concentrate, the reverberatory furnace with deepbath operation to introduce hot calcine charge with Wagstaff Gun, side stream cell circulation system in the tank house, and environmental quality in the plant.

G. EFFECTS-HUMAN HEALTH

03659

T. Toyama, H. Kondoh, and K. Nakamura

PULMONARY PEAK FLOW RESPONSE TO ACID AEROSOLS AND BRONCHODILATOR IN INDUSTRIAL WORKERS. Japan. J. Ind. Health (Tokyo) 4(8):15-23, Aug. 1962. Text in Japanese.

Hydrogen chloride mists (ca. 6 microns in diameter) in an electric appliance factory and sulfuric acid mists (ca. 3 microns in diameter) in a copper smelting industry were inhaled by 22 workers. Their pulmonary ventilatory peak flow rate was compared with 15 control subjects who were not used to such irritant mists. Peak flow rate readings were taken by Wright's flow meter before exposure, after 1 hr of exposure during work, and after bronchodilator (Isoproterenol) inhalation. It was found that the peak flow rate of the controls decreased 9% for the HCl aerosols of 8.68 mg/cu m and 2% for H2SO4 aerosols of 1.88 mg/cu m while the accustomed workers showed no change due to the period of working experience and their tolerance. The decrease in the HCl aerosol was greater since the particles were larger. The bronchodilator effects during acid exposure created a greater increase of peak flow rate in the control group (16% for HCl and 5% for H2SO4 increase from the level of bronchoconstriction than the aerosol workers (2% rise for HCl and 1-3% rise for H2SO4). Considering such factors as droplet size, chemical property, duration of working experience and behavior by bronchodilator, it is concluded that H2SO4 aerosols of submicron size act more persistently as a bronchial irritant and result in more chronic damage to respiratory tracts than larger size HCl aerosols to which mainly the upper part of the airway is irritated in an intense and momentary way. (Author summary modified)

05146

A. Bell

THE EFFECTS ON THE HEALTH OF THE RESIDENTS OF EAST PORT KEMBLA (PART II OF AIR POLLUTION BY METALLURGICAL INDUSTRIES). Public Health Dept., Sydney, Australia, Div. of Occupational Health, 1962. 153pp.

948 residents East Port Kembla were asked a standardized questionnaire in order to determine the prevalence of chronic bronchitis. Smaller numbers of people underwent a pulmonary function and sputum test. Individual findings for the regions of high and low pollution were compared. Residents were specifically questioned to determine the prevalence of nasal catarrh, whether head colds 'settled on the chest', number of times they were confined to bed because of chest illnesses, wheeze, cough, phlegm, and dyspnoea. Out of the 471 people who agreed to participate in the tests designed to determine how many have sputum, 333 were found to be so affected. The nature of the samples returned suggests that the bronchitis present in the area is of a mild type. The results of the pulmonary function tests did not show important differences between the residents in the separate areas. It does not appear that the longer a person lives in any of the three areas, the more likely he or she may develop a lower pulmonary function value. Of the people examined in January, 160 were requested to undergo a second lung test in August. The results found on the two occasions differed very little. Out of the people interviewed 6.7% were diagnosed as suffering from chronic bronchitis.

22118

Bell, Alan and John L. Sullivan

AIR POLLUTION BY METALLURGICAL INDUSTRIES. Public Health Dept., Sydney (Australia), Air Pollution Control Branch, 203p., 1962. 83 refs.

Tests for sulfur dioxide were made in Port Kembla, Australia, where iron and copper ores are smelted, and 947 residents were sent a questionnaire to determine the prevalence of chronic bronchitis, with smaller numbers undergoing a pulmonary function and sputum test. An eastern section of town, in the vicinity of the copper smelter, was the major source of SO2. Gas readings were not spectacular by daily volumetric sampling and an automatic recorder, but a continuous recorder showed that high concentrations of SO2 occurred in episodes of a few hours each. The highest result was 0.62 ppm by the former method, while peaks of concentrations greater than 5 ppm were recorded by the latter approach. Prevailing winds produced higher concentrations during the summer months when they blow frequently from a north-east direction, while pollution is blown seawards during the winter months when westerly winds prevail. When measured as water insoluble solids by a deposit gauge consisting of a six inch diameter conical glass funnel and bottle, summer dust-fall rates exceeded 100 tons per square mile/month within a half mile from the steel industries, but smoke densities were low by comparison with other cities in New South Wales despite frequent evidence of haze. A larger percentage of people living in the area of high pollution considered that they were suffering from either chronic bronchitis or bronchial asthma than in the case of the low pollution area, and only a few people complained of symptoms unrelated to the respiratory tract. Differences between the findings for the two areas were statistically significant, 7 times for women and 3 times for men, when questioned to the prevalence of nasal catarrh, whether head colds settled on the chest, number of times they were confined to bed because of chest illnesses, wheeze, cough, phlegm, and dyspnea. A higher percentage of men wheezed and were affected by cough and phlegm tha was the case for a small group of Englishmen who never worked in the dusty occupations, although this was not the situation when compared with English foundry employees. Out of the 333 sputa collected in East Port Kembla, 84.7% were mucoid and 15.3% of a mucopurulent nature, while pulmonary function tests showed no statistically significant differences between the two areas, except for females aged 70-84. Dental evidence suggested that some external influence might be exerting a harmful effect on the gingival tissues of young people living in the area of high pollution.

32841

METALS FOCUS SHIFTS TO CADMIUM. Environ. Sci. Technol., 5(9):754-755, Sept. 1971.

Environmental pollution due to cadmium is reviewed with respect to basic characteristics, consumption, sources of emissions, effects on human health, and research needs. Cadmium occurs chiefly as greenockite in various zinc, lead, and copper ores. Nearly all the cadmium produced in the world is a by-product of zinc smelting. Domestic consumption of cadmium was more than 15 million tons in 1969, a 13% increase over the figures for 1968. The largest single use of cadmium was the electroplating industry; cadmium was also used for pigments, plastics stabilizers, alloys, and batteries. The sources of most cadmium emissions were mining and metallurgical processing, incineration, recycling of ferrous scraps, and consumptive uses (rubber tires, motor oil, fertilizers, and fungicides). Ambient air contains only small amounts of cadmium, but in the vicinity of certain factories concentrations can be much higher. Excessive exposure can damage the liver, kidneys, spleen, or thyroid. Cadmium is absorbed by either inhalation or ingestion. Only 5% of the ingested cadmium is absorbed by the body; absorption of inhaled cadmium may reach 40%. People who smoke as few as 10 cigarettes daily are exposed to concentrations of cadmium 10-100 times greater than those in the ambient air; smoke from smoldering tobacco that is not inhaled contains more cadmium than the mainstream. Research needs and indicated study programs are discussed.

32842

McCaull, Julian

BUILDING A SHORTER LIFE. Environment, 13(7):2-15, 38-41, Sept. 1971. 48 refs.

Cadmium pollution of the environment is reviewed with respect to basic characteristics, emission sources, uses, concentration levels, and effects on human health. Cadmium dust, fumes, and mist are emitted during the refining of zinc, copper, and lead, as well as during extraction of cadmium. These processes released an estimated 2.1 million pounds (45% of total emissions) into the air in 1968. The single largest source was the roasting and sintering of zinc concentrates. Incineration or disposal of cadmium-containing products contributed 52% of total emissions. The processes included electroplating, recycling of scrap steel, melting down scrapped automobile radiators, and incineration of solid wastes. Cadmium concentrations in the waterways, tap water, food, vegetation, soils, and certain commercial products (fertilizers) were determined. The toxicity of cadmium, levels of ingestion and retention in the body, and correlation with hypertension, liver damage, bone disease, emphysema in industrial workers, cancer, and kidney impairment are examined.

26517

Babushkina, L. G., N. P. Sterekhova, and F. S. Kuzmina

SOME INDICES OF LIPID METABOLISM IN THE BLOOD OF WORKERS ENGAGED IN COPPER WORKS. (Nekotoryye pokazateli lipidnogo obmean v krovi u rabochikh medeplavilnykh proizvodstv). Text in Russian. Terapevt. Arkh., 43(9):100-104, 1971. 26 refs.

Indices of lipid metabolism were determined in the blood of 94 copper smelter workers with toxico-chemical hepatitis pneumosclerosis (in the presence or absence of hepatitis developing due to a chronic action of sulfur dioxide), and in the blood of silicosis patients and donors. All patients showed a significant increase of total lipids content compared to donors. Patients with hepatitis and silocosis showed a moderate increase in Beta-lipoproteids; other patients showed a tendency toward increased levels. The content of Beta-lipoproteids, total lipids, and Beta-lipoproteidipase activity in blood serum correlated with the extent of sclerosis in the lungs and with the inclusion of liver disease in the pathological process. Total cholesterol levels were normal in all patients, but there was a tendency toward increased estherified cholesterol.

42205

Pinto, Sherman S. and B. M. Bennett

EFFECT OF ARSENIC TRIOXIDE EXPOSURE ON MORTALITY. Arch. Environ. Health, 7(5):583-591, Nov. 1963. 36 refs.

The causes of death were studied on a copper smelter among present and pensioned employees dying in the period 1946-1960. The influence of arsenic trioxide exposure was specifically reviewed. Previous work had indicated men in this plant not exposed to arsenic excreted an average of 0.13 mg arsenic/l urine; those exposed excreted an average of 0.82 mg arsenic/l urine. There was no evidence that chronic arsenic trioxide exposure of the amount described is a cause of systemic cancer in humans or has any measurable effect on fatal cardiovascular disease. Neither arsenical dermatitis nor perforation of the nasal septum by arsenic-containing dusts in mentioned, since the dermatitis is considered to be a measure of personal hygiene and not a measure of the amount of arsenic absorbed. (Author summary modified)

47635

Likhacheva, E. I. and F. S. Kuz mina

INTRAHEPATIC HEMODYNAMICS IN PATIENTS WITH CHRONIC SULFUROUS GAS POISONING. (K voprosu o sostoyanii vnutripechenochnoy gemodinamiki u bol nykh s khronicheskoy intoksikatsiyey sernistym gasom). Text in Russian. Gigiena Truda i Prof. Zabolevaniya, 16(2):15-19, 1972. 10 refs.

Intrahepatic hemodynamics in 50 31-45-years-old workers of copper melting plants with at least 10 years chronic occupational exposure to sulfur dioxide was investigated. Twelve of the patients showed no clinical symptoms of hepatic lesions, 27 had toxic hepatitis, and 11 had hepatitis with cholecystitis and cholangitis. Other symptoms such as chronic bronchitis and gastritis were detected. The changes observed in the intrahepatic hemodynamics in patients with clinical picture of toxic hepatitis were apparent in 25% of all cases, even in the absence of other manifestations of toxic lesions of the liver. Such rheohepatographic changes are not a reflection of general circulatory insufficiencies, but may be ascribed to the toxic effect of SO2 on the vascular system of the liver.

H. EFFECTS-PLANTS AND LIVESTOCK

24326

Nikolaevskiy, V. S.

THE EFFECT OF SULFUR DIOXIDE ON WOODY PLANTS UNDER THE ENVIRONMENTA CONDITIONS PREVAILING IN THE SVERDLOVSK REGION. In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Vol. III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown Under Diverse Envinornmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.), Silver Spring, Md., American Institute of Crop Ecology, 1970, p. 58-67. 20 refs. Translated from Russian. (Also: Okhrana Prirody na Urale, no. 4:123-132, 1964.)

A study of gas resistance of woody plants investigating photosynthesis and respiration, water conditions, pH, Eh, and rH2 o cell sap, the movement of stomata, and the quantity of readily oxidizable substances is reported. Also studied were the anatomica properties of leaves and the dynamics of their susceptibility to injury in woody plants growing under conditions of the copper smelting industry of the Central Urals (Krasnoural'sk, Kirovgrad, and Revda), as well as in a laboratory gas chamber where cut branches of plants were used. The physiological indices were studied for five species: balsam poplar, dwarf apple, European white birch, aspen, and box elder. The investigation was carried out under conditions of intermittent gassing (200 m from smelter) and under conditions free of gases (trees in a forest glade of abou 500 m diameter and at a distance of 7 km from the smelter). In the forest glade study the naturally growing aspen and European white birch were utilized. In addition there were planted balsam poplar, dwarf apple, and European white birch. Under the influence of acid gases, and particularly under simultaneously acting urban condition the five investigated species: box elder, balsam poplar, aspen, European white birch, and dwarf apple, showed a distinct reduction in the openings of their stomata in autumn; the extent of this reduction differed for the different species. In the absence of gassing, the reverse was true. The smallest opening of the stomata during the vegetative period was observed in the box elder. This could be the reason for the decrease in the rate of gas exchange, which is conducive to a reduction in the vulnerability of the leave to noxious gases. High concentration of sulfur dioxide causes considerable narrowing of the stomata of the leaves of woody specie and upsets the normal course of physiological processes. Thus, the intensity of photosynthesis drops and respiration is observed in daylight. In addition, acidification of cell sap and a decrease in the quantity of oxidizable matter is also observed. The greater damages, which manifest themselves in appreciable acidification of the cell protoplasm and in an extensive disturbance of photosynthesis, are observed in the less resistant species - dwarf apple and birch. These disturbances appear to a lesser extent in the more resistant species - poplar and lilac.

24734

Kulagin, Yu. Z.

GAS RESISTANCE OF PINE AND BIRCH. In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Volume III. The Susceptibility or Resistance to Gas and Smoke of Various Arboreal Species Grown under Diverse Environmental Conditions in a Number of Industrial Regions of the Soviet Union. M. Y. Nuttonson (ed.) Silver Spring, Md., American Institute of Crop Ecology, 1970, p. 51-57. 10 refs. (Also: Okhrana Prirody na Urale, vol. 4:115-122, 1964.)

Smoke injury to forests and their destruction under the conditions existing in the Southern Urals are intimately connected with the zonal climatic conditions, and, above all, with the weather during the growth season. European white birch and partly Scotch pine can thrive satisfactorily under conditions of intermittent severe sulfur dioxide attacks of short duration. Their gas resistance is conditioned by the occurrence of these attacks in the second half of the vegetative season. Normally, rainy weather, together with changeable winds and low barometric pressure, occurs in July and pushes the noxious gases down close to the ground. Westerly winds prevail in the area under consideration, in the environs of the city of Karabash and its copper smelter. The growth and formation of shoots is almost complete during May and June; the absence of the so-called biological gas resistance but high drought and frost resistance of defoliated birch and pine shoots insures their viability in late summer, autumn and winter, and resurgence of vegetative processes the following season.

27945

Heaney, Robert J., James R. Fletcher, and Alton W. Huffaker

EVALUATION OF SULFUR DIOXIDE INJURY TO ECONOMIC CROPS. Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 21p., 1970. 6 refs. (Presented at the Air Pollution Control Association, Annual Meeting 63rd, St. Louis, Mo., June 14-18, 1970, Paper 70-131.)

When the Utah Copper Division of Kennecott Copper Corporation purchased a copper smelter from the American Smelting and Refining Company, it organized the Agricultural and Meteorological Research Department to monitor the atmospheric concentrations of sulfur dioxide and other pollutants, as well as to evaluate any damage to vegetation that could be attributed to the smelter operations. One of the prime responsibilities of the new organization was to maintain good communications with the farmers in the area and continue the policy of crop damage payments that has been established by the American Smelting and Refining Company. Background information is given on the development of the injury payment program and its scientific basis. Evaluation of SO2 injury to vegetation is carried out by using a diagonal sampling pattern across a given field and taking a ten-stem sample at regular intervals to make a total sample which will be representative of th whole field. Ten representative stems are selected from the sample having SO2 injury, and a total leaflet count is made on these ten stems. The estimated percent of leaflet area injured is reported o one hundred leaflets and the average is reported.

Total injury is calculated by multiplication of the three reported percentages: the percentage of stems with SO2 injury, leaflets having injury, an the amount of leaflet area injured. These data are applied to the total yield of the crop obtained from available records or estimate taken at the time of harvest. Statistical analysis of the injury data has been utilized to develop a regression equation for calculating economic crop loss as a function of marked stems or the product of marked stems and marked leaflets. Data are also presented on the total annual economic value paid out for crop injury and the effect of emission controls in the reduction of economic loss by crop owners. (Author abstract modified)

34867

Bischoff, O. and Fr. Haun

POISONING OF DOMESTIC ANIMALS THROUGH COPPER AND ARSENIC CONTAINING FLY DUST. Deut. Tieraerztl. Wochenschr., 17(28):442-447, July 15, 1939. 8 refs. Translated from German. 19p.

Several weeks after reactivation of a copper smelter on the border between the states of Hesse and Westphalia, cattle, horses, chickens, and sheep in the area exhibited symptoms of poisoning. Subsequently, many animals died or had to be slaughtered. The poisoning was traced to the copper- and arsenic-containing fly dust emitted by the smelter and deposited on plants and grasses in grazing pastures, particularly in the presence of dew and fog. Early clinical symptoms of poisoning included conjunctivitis, stomach and intestinal catarrh, secretion of saliva, miscarriages, emphysematose foeti, retention of afterbirths, and reduction or complete stoppage of milk production. Autopsies of deceased or slaughtered animals revealed considerable enlargement of the liver. Liver copper concentrations were 80 mg/kg in cattle and horses and 75-250 mg/kg in sheep. Plant fly dust contained 2.5% copper and 23 mg arsenic trioxide (As203). Symptoms first appeared in animals 0.5-1.5 km from the smelter, but animals grazing as far away as 4.5-5 km were also affected. Of 2100 cattle in the four communities closest to the smelter, 520 animals perished. Milk production in the four communities was reduced by about 75%. Copper levels in animals and animal organs (liver, Kidney, spleen, heart, blood) are tabulated.

36968

Wullstein, L. H. and Kristen Snyder

ARSENIC IN THE ECOSYSTEM. Preprint, 4p., 1970. 24 refs. (Presented at the International Air Pollution Conference, 1970.)

The effects of arsenic on rates of mineralization in soil were investigated using samples subjected to pollution from a copper smelter. The samples contained up to 245 ppm arsenic compared with control samples containing 10 ppm arsenic. Mineralization was studied by adding a constant amount of peptone to the samples and comparing the rates of ammonification, nitrosofication, and nitrification. Then concentrations of 50, 150, and 250 ppm arsenic were added to the control samples and similar mineralization rates were determined. Ammonification rates of the polluted and control samples amended with both peptone and arsenic were similar; however, rates at which ammonium was oxidized differed. Nitrosofication and nitrification rates of the polluted samples were reduced compared to those of the control samples. Field methods of soil sampling, laboratory procedures, including determination of moisture, pH, total and gaseous arsenic, total nitrogen, and soil respiration, and complete test results are discussed. (Author abstract modified)

38017

Guderian, R., H. van Haut, and H. Stratmann

PLANT-DAMAGING HYDROGEN FLUORIDE CONCENTRATIONS. (Pflanzenschaedigende Fluorwasserstoff-Konzentrationen). Text in German. Umschau (Berlin), 71(21):777, 1971. 2 refs.

Because of increased emissions of fluorine-containing gases from plants manufacturing aluminum, copper, superphosphate, glass, or cement, tests were conducted to determine the effect of various concentrations of atmospheric hydrogen fluoride on a variety of plants. Varying harmful effects were noted with concentrations of 0.85-4.2 micrograms/cu m in air, but no definite conclusions regarding allowable concentration limits were reached.

39690

Ebaugh, W. Clarence

GASES VS. SOLIDS: AN INVESTIGATION OF THE INJURIOUS INGREDIENTS OF SMELTER SMOKE. J. Am. Chem. Soc., 29(7):951-970, July 1907. 4 refs.

The relative effects of sulfur dioxide and flue dusts in smelter smoke upon vegetation were investigated in the Salt Lake City area to assess the damages due to emission from lead and copper smelters. The concentrations of SO2 were monitored, and the effects of free SO2, sulfuric acid, SO2 in aqueous solutions, and dilute solutions of H2S04 were individually examined. Flue dust samples were analyzed for percent content of moisture, sulfur trioxide, iron, copper, insolubles (silicon dioxide), lead, arsenic, and zinc. Many repeated applications of SO2 in concentrations present in the air of a smelting district were needed to cause injury, the degree of which was dependent on humidity. Solutions of H2S04, if present to the extent of 1.38 g/l or stronger, caused marked corrosion. Solutions of flue dusts sprayed upon plants resulted in very severe corrosion. Soil mixtures containing 20% of the flue dust, when applied to plants, also caused very bad corrosion.

39718

Lipman, C. B. and Frank H. Wilson

TOXIC INORGANIC SALTS AND ACIDS AS AFFECTING PLANT GROWTH. Botan. Gaz., 55(6):409-420, JJune 1913. 10 refs.

The physiological effects of copper sulfate, zinc sulfate, manganese sulfate, and sulfuric acid emitted from smelter processes on plant growth were investigated. The plants were actually stimulated by quite considerable quantities of the toxic salts, indicating a much greater tolerance than previously assumed. The limits of toxicity, therefore, must be studied in greater detail to determine what concentrations of the toxic salts will inflict injuries.

39933

Formad, Robert J.

THE EFFECT OF SMELTER FUMES UPON THE LIVESTOCK INDUSTRY IN THE NORTHWEST. Dept. of Agriculture, Washington, D. C., Pathological Div., Bureau of Animal Industry Rept. 25, p. 237-268, 1908. 54 refs.

The effects of copper smelter fumes on the livestock industry in Deer Lodge Valley, Montana were investigated. Pastures, soil, water supply, hay, sheds, and stables were examined along with the physical conditions of the animals. Large amounts of arsenic were determined in grass, hay, leaves, and tree bark. Livestock losses were estimated from records; of a total 2447 horses in 1902, only 423 remained in 1906, and the losses in cattle were even greater. Animal experiments with ar-

senic poisoning were conducted to compare the experimental results with the clinical symptoms of the Deer Lodge vally livestock. The symptoms varied with the kind of forage consumed by the animals, but included as an effect of the fumes a failure to conceive, abortion, and finally sterility. Losses due to failure to conceive and abortion ranged within 30-60%. Pathological examinations on post mortems showed lesions of chronic catarrhal inflammation of the stomach, intestines, lungs, and kidneys and inflammatory cell proliferation in the mucous membranes of the stomach and intestines, the liver, the lung, and the kidneys.

40581

Harkins, W. D. and R. E. Swain

THE CHRONIC ARESENICAL POISONING OF HERBIVOROUS ANIMALS. (PAPERS0 ON SMELTER SMOKE, THIRD PAPER). J. Am. Chem. Soc., 30(6):928-946 June 1908. 16 refs.

An outbreak of arsenical poisoning occurred among cows, horses, and sheep in the district surrounding Anaconda, Montana, during the year 1902-1903. Operation of the Washoe smelter at Anaconda and autopsies of a large number of animals are discussed. The amounts of arsenic present in the organs of the animals is in many cases small, yet no smaller than might reasonably be expected in chronic arsenical poisoning following the repeated and regular administration of moderate doses of arsenic. In order to see how the results of autopsy would compare with those obtained from animals killed by arsenic, and also to secure data as to the poisonous dose, horses were fed upon arsenic in different forms. The elimination of arsenic probably begins very early and persists during the whole period of its absorption. The proof of posioning is considered. Symptoms of chronic arsenical poisoning include proliferation of the connective tissue cells, degeneration and desquamation of the tubules in the kidneys, congestion or diapedesis, the occurrence of hemorrhagic areas, and occasionally a total disintegration of the cells. Other symptoms are described, as well as the results of an experiment in which sheep were exposed to arsenic trioxide.

42250

Costesque, L. M. and T. C. Hutchinson

THE ECOLOGICAL CONSEQUENCES OF SOIL POLLUTION BY METALLIC DUST FROM THE SUDBURY SMELTERS. Inst. of Environmental Sciences, Mt. Prospect, Ill., Proc. Inst. Environ. Sci., Annu. Tech. Meet., 18th, New York, 1972, p. 540-545. 16 refs. (May 1-4.)

The ecological consequences of heavy metal damage are probably being masked by the damage due to sulfur dioxide emitted by the metal smelters of Sudbury, Ontario in Canada. Soil and vegetation east and south of the source, plant leaves, and dust and rainfall were sampled for analysis of copper, nickel, cobalt, zinc, manganese, lead, and iron content. Elevated levels of nickel were detected up to 31 mi from the smelters and toxic water levels extended to 10 mi. The soil contamination has a pattern indicative of an airborne smelter source. A significant reduction of pH occurred in the soil within 1 1/2 mi of the smelter. A pH of 2.2 was recorded in one instance, suggesting the presence of free sulfuric acid. Nickel levels were 2835 ppm at 0.5 mi from the smelter, 1522 ppm at 4-5 mi, 306 ppm at 12 mi, and 83 ppm at 31 mi. Copper followed the same pattern from 1528 ppm to 31 ppm; cobalt decreased from 127 ppm to 19 ppm. Average soil levels should be 40 ppm for Ni, 20 ppm for Cu, and 8 ppm for Co. (Author summary modified)

43787

Wu, Lin and A. D. Bradshaw

AERIAL POLLUTION AND THE RAPID EVOLUTION OF COPPER TOLERANCE. Nature (London), 238(5360):167-169, July 21, 1972. 10 refs.

The copper tolerances of 30 individual genotypes of each of four populations of the grass Agrostis stolonifera from the area of a metal refining industry emitting large amounts of copper dust and two populations from uncontaminated grassland were measured. In the population on the boundary of the refinery area there is a considerable increase in the occurrence of tolerence, yet this population is more or less continuously distributed and there are several other species; this supports the idea that selection of different genotypes for copper tolerance from an original non- tolerant population is only occurring now. Tolerances of populations from a dune grassland and a park at some distance from the refinery had uniformly low tolerance. In a separate experiment, seeds were collected from the dune grassland, a zinc and lead mine, a normal pasture, another lead mine, boundary grassland at the refinery, and grassland near a canteen at the refinery. The seeds were sown on toxic soil from the refinery containing 10,260 ppm Cu. After 10 weeks, mean height and percentage of rooted seedlings were determined in samples of 2000 seeds for each population. There was no difference in the height and the percentage of rooted seedlings between the four seed populations collected from sites not contaminated by copper when grown on refinery soil; but there was a significant increase in the mean height and percentage of rooted seedlings in the two refinery populations. Although most of the seedlings from uncontaminated sites died after the experiment, some survived well. These seedlings seem to be tolerant and may give rise to a tolerant subsequent generation.

J. EFFECTS-ECONOMIC

30696

LeSourd, D. A., M. E. Fogel, A. R. Schleicher, T. E. Bingham, R. W. Gerstle, E. L. Hill, and F. A. Ayer

COMPREHENSIVE STUDY OF SPECIFIED AIR POLLUTION SOURCES TO ASSESS THE ECONOMIC EFFECTS OF AIR QUALITY STANDARDS. VOL. I. (FINAL REPORT). Research Triangle Inst., Durham, N. C., Operations Research and Economics Div., APCO Contract CPA 70-60, RTI Proj. OU-534, Rept. FR-OU-534, 395p., Dec. 1970. 328 refs. NTIS: PB 197647

Air pollution control costs for mobile sources are presented on a national basis and in terms of unit investment and annual operating and maintenance costs as well as total annual operating and maintenance costs. The analyses cover the estimated emissions and control costs for new cars for Fiscal Year 1967 through Fiscal Year 1976. Control costs for each stationary source, except for residential heating, are shown for 298 metropolitan areas by investment and annual expenditures by Fiscal Year 1976. The impact of control on selected industries and the Nation are also determined. Finally, an extensive bibliography is included. The pollutants from mobile sources selected for analysis are hydrocarbons, carbon monoxide, nitrogen oxides and particulates. The six pollutants for which control cost estimates are made for stationary sources are particulates, sulfur oxides, carbon monoxide, hydrocarbons, fluorides, and lead. Emission standards applied are considered stringent in comparison with many currently in use throughout the Nation. Mobile sources include automobiles and light and heavy-duty trucks. Stationary sources studied include solid waste disposal, commercial and institutional heating plants, industrial boilers, residential heating plants, steam- electric power plants, asphalt batching, brick and tile, coal cleaning, cement, elemental phosphorus, grain handling and milling (animal feed), gray iron, iron and steel, kraft (sulfate) pulp, lime, petroleum products and storage, petroleum refineries, phosphate fertilizer, primary non-ferrous metallurgy (aluminum, copper, lead and zinc), rubber (tires), secondary nonferrous metallurgy, sulfuric acid, and varnish. Data essential for defining metropolitan areas, emission control standards, and relevant process and air pollution control engineering characteristics required to support the cost analyses for each source and the cost impact on each industrial process are presented and analyzed in separate appendixes to this report. (Author abstract modified)

35321

EMISSIONS CONTROVERSY ENTERS PHASE II. Eng. Mining J., 172(12):78-81, Dec. 1971.

The copper industry contends that almost insurmountable economic-enginerring problems stand between it and compliance with the 90% sulfur control standard adopted by various states. Producers in Washington and Arizona are currently petitioning for lower standards. Sulfuric acid production, the only well-established method for removing sulfur oxides from smelter gases, will not of itself yield 90% sulfur control. New technology is required for the smelting, handling, and concentrating of normally dilute gases from reverberatory furnaces. Estimated capital costs for copper smelters to meet the 10% emission limit in the required time limits range from $600 million to one billion. Given time to develop adequate new technology, the collective cost to the industry could be $345 million. Further cost data should become available this year with the release of a cost control study contracted by the Environmental Protection Agency. The 10% emission limit for sulfur is not a part of federal law. Several smelters may approach or meet federal primary and secondary ambient air standards due to location, meteorological conditions, feed sulfur content, and smelting practice.

46282

Falk, George B., Anthony W. Yodis, and William D. Hunter, Jr.

SULFUR RECOVERY FROM SMELTERS--A CHEMICAL POINT OF VIEW. Preprint, American Inst. of Chemical Engineers, New York and Inst. Mexicano de Ingenieros Quimicos, 19p., 1970. 3 refs. (Presented at the American Institute of Chemical Engineers and Institute de Ingenieros Quimicos Joint Meeting, 3rd, Denver, Colo., Sept. 2, 1970, Paper 45a.)

Reduction of sulfur dioxide to sulfur by methane is effectual only when feed gas is steady in flow and composition and low in oxygen. Interposing a dimethylaniline (DMA) sorption system before methane reduction will increase the SO2 concentration, eliminate the oxygen content, and level the highly variable flow and composition of copper smelter gases. The costs involved in this process are discussed. The DMA concentrator can accept both reverb and converter gases, so no portion of the stack gas needs to be neutralized. Sulfur credits can, therefore, be maximized. A DMA plant, sized to handle 130% of a smelter s average gas flow, is estimated to cost $12.5 million. The operating cost comes to $32/NT sulfur.

K. STANDARDS AND CRITERIA

14443

Knop, W.

AIR POLLUTION CONTROL IN NON-FERROUS METAL INDUSTRIES. II. PARTICULATE AND GASEOUS EMISSIONS OF THE NON-FERROUS METAL INDUSTRY AND EMISSION STANDARDS. (Luftreinhaltung im NE-Metall-Betrieb. II. Staub-und gasfoermige Emissionen der NE-Metallindustrie und die Emissionsbegrenzung.) Text in German. Metall., 22(12):1266-1271, Dec. 1968. 21 refs.

In this review article, the West German air pollution laws and regulations as applied to metallurgical plants are compiled and discussed. In the aluminum industry, dust arises both in the production of aluminum oxide from bauxite and in the electrolytic furnaces. The most dangerous component of the waste gas is fluoride of which the maximum allowable concentration is 2.5 mg/cu m. Lead refineries emit considerable amounts of dust, up to 15 g/cu m waste gas, which contains metal compounds in the form of sulfates, oxides, sulfides, and coke dust. The pollutants originating in the various steps of lead production are discussed in detail. The threshold limit value (TLV) of lead is 0.2 mg/cu m. Electrometallurgical furnaces for iron and steel alloys emit very fine dusts (less than 0.4 micrometer), typically up to 250 kg/hr at 10,000 kva capacity. Metal oxides predominate, especially iron and silicon oxides. The waste gases of copper ore refineries contain mostly fly dust and sulfur compounds. The dust contains copper, zinc, and sulfur. Typical concentrations at various stages are listed. The TLV of copper is 1 mg/cu m. Emissions of zinc plants are listed, and waste gas and soot emissions of oil, coke, and coal furnaces are discussed in detail. Special problems are posed by scrap metal refineries, where plastics and varnishes cause air pollution. Typical examples are cited.

26721

RESTRICTION OF EMISSION: COPPER-SCRAP SMELTING PLANTS AND COPPER REFINERIES. VDI (Verein Deutscher Ingenieure) Duesseldorf (West Germany), Kommission Reinhaltung der Luft, Richtlinien 2101, Oct. 1966. 13 refs. Translated from German. Israel Program for Scientific Translations, Jerusalem, 8p. NTIS: TT-68-50469/9

The sources of dust emissions in contemporary copper extraction processes are indicated, together with suitable methods of restricting the emissions. The processes considered include smelting of copper-containing waste and scrap in shaft furnaces; blowing of black copper to crude copper in converters; refining of converter copper in refining furnaces; the electrolysis of anode copper; and the melting of copper cathodes in wirebar furnaces. Fabric filters are recommended for collecting the dust contained in flue gas from shaft furnaces and converers, while cyclone separator are recommended for treatment of emissions from copper-anode and wirebar furnaces. Recommended standards for maximum emissions from each furnace are presented.

29376

Swan, David

STUDY OF COSTS FOR COMPLYING WITH STANDARDS FOR CONTROL OF SULFUR OXIDE EMISSIONS FROM SMELTERS. Mining Congr. J., 57(4):76-85, April 1971. (Presented at the National Industrial Pollution Control Council meeting, Washington, D. C., March 8, 1971.)

The concentration of copper smelters in the U. S. is indicated and sulfur dioxide emissions from these smelters are related to the ambient air quality requirements of the Clean Air Act Amendements of 1970. Capital costs, derived from computer studies of smelters representing 88% of the U. S. copper-smelting capacity, are presented for technological alternatives for meeting primary ambient air standards or 90% emission control standards. The various alternatives using existing technology applied on an industry-wide basis would cost $500 million to $1.2 billion. For instance, the choice of production curtailment, air dilution, and sulfuric acid plants would require an investment of about $572 million. This system would meet the 24-hr ambient requirement but not the 90% emission standard. Replacing smelters using acid plants as the primary SO2 recovery method would cost $1.2 billion. This would meet the annual ambient and the 90% emission standard. Of the technology now being tested commercially, limestone scrubbers would meet the annual and 24-hr ambient requirements but not the 90% emission limit. The would require an industry investment of $293 million. If the scrubber were followed by a caustic scrubber, the investment cost would increase to $345 million. This equipment would meet the annual ambient standard and the 90% emission limit, but would introduce a by-product disposal problem. It is suggested that the 90% emission requirements be eliminated and that the time allowance for development of new processes to meet the Clean Air Act requirements be extended.

31917

Muth, Robert J.

ORIGINS AND CURRENT STATUS OF SULFUR OXIDE EMISSION STANDARDS FOR NONFERROUS SMELTERS. Mining Congr. J., 57(8):63-70, Aug. 1971. 24 refs.

Federal and state air pollution agencies and the copper smelting industry are at odds over the requirement that copper smelters be permitted to emit no more than 10% of the sulfur contained in materials processed. This requirement, generally referred to as a 90% emission control standard, is forcefully advocated by the Air Pollution Control Office. It has been adopted by the states of Montana, Arizona, and Nevada, and by the Puget Sound Air Pollution Control Agency in Washington. However, a combination of economic and technical factors make implementation of the standard impossible for almost all existing smelters. Compliance with the standard by converting sulfur dioxide in the more concentrated gas streams to sulfuric acid would produce enormous amounts of acid for which no ready markets exist. The more dilute gases, which can account for 25% or more of total sulfur dioxide produced in the smelting process, are not amenable to conventional

treatment. Thus, existing smelter processes may have to be replaced with new processes capable of generating more concentrated gas streams. The capital costs for new process equipment and pollution control equipment are estimated at over half a billion dollars, based on present costs. Since nonferrous metals are international commodities, the domestic industry would be unable to recoup increased costs by increasing prices.

L. LEGAL AND ADMINISTRATIVE

00694

T. W. Barrett

THE USE OF ARBITRATION PROCEDURES IN THE SETTLEMENT OF CLAIMS OF DAMAGE TO VEGETATION CAUSED BY INDUSTRIAL EFFLUENTS. Preprint. (Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Canada, June 20-24, 1965, Paper No. 65-94.)

On 18 May 1955 the United States District Court for the District of Arizona issued a decree (No Civ. 790-TUCSON) that provided to those farmers of the Sulphur Springs Valley, Cochise County, Arizona, who so desired, a means of settling their claims of crop damage by arbitration rather than by court action. The damage to their crops resulted from sulfur dioxide produced by a copper smelter operating in this area. The provisions of the decree and the functions of the Arbitration Committee are all designed to insure prompt, just and adequate compensation to the farmer for any damage sustained by his crops. Arbitration procedures are particularly adaptable to smelter smoke damage to growing crops and have been available over the past nine years to farmers in the Sulphur Springs Valley of Arizona. (Author abstract)

22045

Guccione, Eugene

HOW POLLUTION WATCHERS IGNORE FACTS IN COPPER INDUSTRY'S SO2 EMISSIONS. Eng. Mining J., vol. 171:98-101, Aug. 1970. 6 refs.

New and stringent air-pollution control regulations have been passed in Utah, Montana, Arizona, and Washington requiring copper companies to limit sulfur emissions from smelters' smokestacks to 10% of the total sulfur present in the concentrate ore. As if technology could be created by majority vote, it is objected that the procedure of setting standards via public hearings will continue to produce unreasonable regulations that will leave pollution unabated while greatly harming industry. Industry's frustration regarding anti-pollution regulations, in the case of copper companies, is that it can operate only within the limits of existing technology. The Arthur G. McKee and Co. report of 1969 is cited as having pointed out to HEW the difficulty in recovering sulfur oxides from smelter gases. It is suggested that while technology takes its course, a good place to begin solving the problems of pollution is in the judiciary branch of government, not in the legislative and executive branches. Lack of agreement between the various methods for sulfur dioxide measurement is also pointed out, as well as the difficulty in establishing a clear-cut cause and effect relationship between air pollutants and impairment of health.

32808

Dayton, Stan

TREASURY READIES A NEW TIME BOMB. Eng. Mining J., 49(16):80-81, July 1971.

As originally conceived, the expected tax on sulfur would operate under a formula that would charge one cent a lb on sulfur emitted into the atmosphere in the first year and escalate an additional one cent a lb each year thereafter to a maximum of 100 a lb in the tenth year. One company estimates that the sulfur tax could drain copper producers of $144 million a year. The Fluor Utah report concluded that present proven technology can achieve ambient air quality standards but cannot satisfy an allowable emission rate based on 10% of smelter feed. This report points out that it might be possible to achieve standards using only limestone scrubbing in series with acid production, but modeling results for this method were considered so marginal as to be inconclusive.

36879

Ministry of International Trade and Industry (Japan) and Okayama Prefecture (Japan)

REPORT ON THE SECOND CONFERENCE ON THE MIZUSHIMA AREA AIR POLLUTION CONTROL. (Dainiji Mizushima chiku taiki osen boshi taisaku kyogikai chosa hokokusho). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 7(12):709-723, Dec. 1971.

Okayama prefecture and Kurashiki city formed the Mizushima Area Air Pollution Control Council in Sept. 1967 and began a comprehensive study of the area s air pollution conditions with the general development plan of the coastal industrial complex in the Kurashiki-Mizushima area. A pollution monitoring center was constructed at a central location and the pattern of pollution and transition were studied since then. In spite of the fact that the total emission of sulfur dioxide increased between 1967 and 1971 from 2,751.84 N cu m/hr to 7,981.75 N cu m/hr, the total pollution index has not increased in the area. Up to 1969, high stack emission sources were increased without decreasing the emission amount from low sources, and no improvements had been made on systems at sources. After 1970, collectivization of low emission sources and the use of low-sulfur oil progressed and some measure of pollution control was achieved. As part of the planning for the future development, an air pollution prediction was made upon the projected plan for an area to be newly developed by landfill. Factory layout, possible industrial classifications, production scales, and locations were designed; projected classifications were oil refining, petroleum chemicals, copper refining, aluminum manufacturing, copper wire stretch formation, special steel, glass manufacturing, and shipbuilding. Of these eight industries, three to six were combined, forming four different combinations for simulation tests. Wind tunnel tests were conducted with considerations for seasonal, climatic, fuel, emission gases. If the average sulfur content in fuels is kept under 0.8%, even with the combinations of multi-industries and with the conditions of already functioning industries in the surrounding area, the environmental standard could be maintained.

44265

Gabrisch, R.

DEVELOPMENT AND EFFECTS OF LEGAL REGULATIONS CONCERNING METALLURGICAL PLANTS AND REMELTING PLANTS. (Entwicklung und Auswirkung behoerdlicher

Auflagen fuer Metallhuetten und Umschmelzwerke). Text in German. Preprint, Gesellschaft Deutscher Metallhuetten und Bergleute, Clausthal-Zellerfeld (West Germany), 12p., 1972. (Presented at the Gesellschaft Deutscher Metallhuetten und Bergleute-Hauptversammlung, Stuttgart, West Germany, April 26- 30, 1972.)

One hundred and forty-four metallurgical plants and recasting plants existed in the Federal Republic and West Berlin in 1971. The total turnover was about one billion dollars, 0.8% of the entire industrial turnover. Despite this relatively small fraction of the total industrial turnover, the expenditures for air pollution control measures are remarkable. The new regulations which became effective in 1971 tie the licensing of all melting plants for non-ferrous metals to the presence of the most modern air pollution cleaning facilities. Vacuum melting plants and melting plants for up to 50 kg light metals or 200 kg heavy metals and melting plants for precious metals are excluded. In 1964 the Technical Directives for the Maintenance of Clean Air (TAL) were enacted. They demanded that the sulfur dioxide emissions by lead and zinc plants be reduced as far as possible by passing the roasting and sintering gases to a sulfuric acid production plant. The particulate emissions were limited to 400 mg/cu m during continuous operation for waste gases from lead blast furnaces, from lead reverberatory furnaces, and from zinc muffle furnaces. The particulate emission from lead refineries and zinc distillation plants was limited to 200 mg/cu m. Emissions from copper processing could contain as much as 500 mg/cu m dust. In 1966 this limit was reduced to 300 mg/cu m. For secondary aluminum plants a guideline is being worked out which will recommend the limitation of the particulate emissions from all melting aggregates to 150 mg/cu m and from thermal degreasing plants to 100 mg/cu m. In secondary zinc and copper plants, the maximum allowable emission will be limited to 50 mg/cu m because of the toxicity of zinc and copper. The metal recovery from old cables is connected with emission problems which still require a solution. At present no cable burning plant in Germany is equipped with any dust cleaning devices.

N. GENERAL

05114

Johnson, Ralph K.

THE NEW HAYDEN SMELTER - ITS UNIQUE DESIGN FEATURES. J. Metals, p. 376-381, June 1959.

The smelter's ultra-modern design features are described. The plant is impressive; it is scrupulously clean and well laid out. It was reported that 131 men were being used on the three-shift operation, which is in marked contrast to the 170-man force at another smelter of comparable size. The charging system of the furnace permits easy handling of the concentrates and their efficient introduction into the furnace. The preheater for the air for the furnace burners results in higher operating temperatures in the furnace and hence an increase of some 40 pct in the furnace output. It is estimated that reverb furnace output may be increased by as much as 8 pct by using drier concentrates. The reverberatory and converter flue gases are treated for final dust separation in a four-chamber, 60 gas duct, three-field-type, electrostatic precipitator. The capacity of the precipitator is 300,000 cfm at 10 pct moisture and 500 degree F. All dust rappers are of the pneumatic type, and the dust is collected and transported to the pug-mill by screw conveyors. The fields are energized by six, 30-kva, double-half-wave, selenium power units. From the precipitator, the gases are channeled by a brick by-pass flue to the 600-ft high, brick-lined, reinforced-concrete stack where they exhaust to atmosphere.

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